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THE NEW PHYSIOLOGY OF VISION

Chapter VIII. The Perception of Polarised Light

SIR C. V. RAMAN

ONE of the most remarkable of our visual faculties is the ability to recognise polarised light and to locate its plane of polarisation. It is the foveal region of the retina that exhibits this power which, it may be remarked, is limited to light appearing in the wavelength range between 400 mμ and 500 mμ. The fovea is the most useful part of the retina and the blue-violet sector in the spectrum covering this range of wavelengths stands in a category by itself as the most colourful and yet the least luminous part of it. Clearly, therefore, the process by which the fovea is enabled to recognise the presence of polarisation in light appearing in this restricted range within the spectrum and is unable to achieve the same result in other parts of it, merits scientific investigation. Indeed, one may well expect that such an investigation would throw much-needed light on the fundamental aspects of the physiology of vision. The studies of which the results are described in this chapter were undertaken with that object.

Haidinger's Brushes.—The blue colour of the sunlit sky has its origin in the scattering of sunlight by the molecules of the earth's atmosphere. Skylight accordingly exhibits a high degree of polarisation when observed in a direction transverse to the rays of the sun. As a consequence, observation of the parts of the sky which exhibit the maximum degree of polarisation should enable us to demonstrate the ability of our eyes to perceive and determine the state of such polarisation. The effects thus arising are best looked for in the forenoon of any bright clear morning when the sun is well up above the horizon. The observer should stand with his back to the sun and view the regions of the sky where the maximum of polarisation is to be expected. These regions would evidently lie along the arc of a great circle which runs at a slant across the sky. Scanning this circle rapidly with his eyes, the observer will notice a band along the circle which appears bluer than the rest of the sky and which is bordered on both sides by bands of the same width exhibiting a distinctly yellowish hue. On fixing his attention at a particular part of the circle to his left, it will be found that the colours seen in that region soon fade away from sight. The observer should then turn quickly and fix his attention on the part of the great circle to his right which is ninety degrees away from the original point of fixation on the left. He will then notice in this region a very striking phenomenon, *viz.*, a dumbell-shaped blue brush of light having its axis on the great circle of maximum polarisation of skylight and crossing this brush a yellow brush of light of similar shape with its axis transverse to that circle. These brushes are conspicuous when first seen, but when the observer continues to gaze at them, they fade away from sight. He should then again turn quickly to the region on the circle previously viewed. He will then notice in that region a similar conspicuous manifestation of the blue and yellow brushes crossing each other. This alternation between the left and the right can be repeated as often as desired.

Studied in the manner described, the nature and origin of the phenomena become clear. What the observer perceives is an enormously enlarged picture of the foveal region in the retinæ of his own eyes projected on the sky and manifesting itself by reason of the visual response of the fovea to the light incident on it. The spectral character of that light, its state of polarisation and the orientation of the plane of polarisation in relation to the fovea are the factors which determine the nature of the picture perceived. The circumstances in which it is observed indicate that the conditioning of the eye by an earlier exposure to polarised light also plays a highly important role. The entire light of the spectrum is polarised, but the part of the spectrum not included in the range of wavelengths between 400 mμ and 500 mμ behaves quite differently from the part which is included in that range. It is the latter part of the spectrum that evokes a powerful visual sensation in the two sectors of the fovea of which the axis is parallel to the direction of vibration in the incident light. The two other sectors of which the axis is perpendicular to that direction are not thus excited. Since these differences appear only in the blue-violet sector of the spectrum, the visual sensation in the former case manifests itself as a brush of a bright blue colour. In the latter case, the absence of any sensation in the blue region of the spectrum results in only the rest of the

spectrum being perceived. The manifestation of a yellow brush crossing the blue brush is thus accounted for.

The blue and yellow brushes and the regions in the fovea which they represent interchange positions when the observer shifts his vision from the part of the sky on his left to another on his right located ninety degrees away from it. The regions of the fovea which are not excited in one case are those excited in the second case and *vice versa*. The sectors are thus conditioned by the first exposure respectively to respond and not to respond to the second exposure. Accordingly, the blue brush and the yellow brush both turn round through a right angle and manifest themselves conspicuously to the observer's vision.

The Spectral Characteristics.—As stated above, the ability of the fovea to perceive polarisation is restricted to the blue-violet part of the spectrum. In other words, polarisation is detectable throughout the spectral range between 400 mμ and 500 mμ but is unobservable in the region of greater wavelengths. A simple technique by which these facts can be demonstrated has been devised by the author. A brilliantly illuminated part of the sky (close to the sun) is viewed through the long slit-shaped opening between the two shutters of a window by the observer who takes up a position at a suitable distance from the opening. Holding a diffraction grating before his eye, the observer can view the first-order spectrum produced by it and can direct his vision to any particular part of the spectrum and scan the entire spectrum from end to end. Insertion of a polaroid before the grating results in polarising the light appearing in the spectrum. Two brushes are then seen crossing each other, one of them being a bright brush and the other a dark brush. When the polaroid is rotated, both the brushes rotate together in the same direction as the polaroid. The brushes can be very clearly seen in the blue-violet sector of the spectrum. But they are not observed in other parts of the spectrum.

That the polarisation of light is undetectable by the unaided vision if the wavelength of the light exceeds 500 mμ also becomes evident when the observer makes use of a colour filter which completely cuts off all wavelengths less than 500 mμ while freely transmitting greater wavelengths. Glass filters having such a spectral behaviour are commercially available and they appear of a golden-yellow colour by transmitted light. Viewing an extended source of light through such a filter with a polaroid placed in front which can be turned round in its own

plane, critical examination fails to reveal any observable brushes in the field of view. *Per contra,* the use of a colour filter that cuts out all wavelengths greater than 500 mμ and transmits shorter wavelengths enormously facilitates the observation of the brushes. Instead of a blue brush crossed by an yellow brush, we have then a bright brush crossed by a dark brush both appearing in a field exhibiting the colour of the transmitted light. The contrasts in respect of luminosity then manifested make the whole phenomenon very conspicuous. The axis of the bright brush is parallel to the direction of vibration in the polarised light, while the axis of the dark brush is transverse to that direction.

Techniques of Observation.—The use of a colour filter to eliminate the unwanted parts of the spectrum and of a polaroid to secure complete polarisation of the light in any desired azimuth makes further critical studies possible. Observations can then be made under controlled laboratory conditions and artificial light sources having the desired spectral characters can also be utilized. By such studies, it can be established that, though restricted to the blue-violet sector of the spectrum, the ability to detect polarisation belongs to the same category of visual phenomena as the perception of light form and colour and that it stands in the closest relationship with these perceptions. The difficulty which presents itself in the evanescent character of the phenomenon can be overcome by the adoption of a suitable technique. Holding the colour filter together with the polaroid in front of his eye, the observer should view an extended source of light. The polaroid should be held at first in particular orientation and then smartly turned round in its own plane through a right angle. It should then be held in the new position for a little while and later turned back again to the original position. These movements may be repeated as often as desired. Immediately after the polaroid is turned into a new orientation, the brushes are seen at their best, a bright brush along the direction of vibration in the transmitted light and a dark brush in the transverse direction. The brushes fade away soon, but they reappear in full strength in the new position when the polaroid is turned again through a right angle.

The extended sources of light needed for the study are most conveniently accessible out-of-doors, sunlit clouds being the most luminous. Next in order comes skylight, the brightness of which varies enormously with the part of the sky under observation, as also with the time

of the day. In the vicinity of the sun, especially when it is covered by a thin haze, skylight can be extremely brilliant. Further away from the sun, the luminosity falls off rapidly. It also becomes very weak in the twilight hours. Indoor observations may also be made using screens which receive their light from open windows. If the screen employed is of the type used for projection work, consisting of a great number of tiny glass-balls embedded in a plastic sheet, a fairly high luminosity may be achieved. Other screens are, of course, less satisfactory. It should be remembered that the combination of a blue-filter with a polaroid transmits only a very small part of white light. The need for a high intrinsic luminosity when an extended source of light is viewed through such a combination is obvious.

For observations indoors with monochromatic light, the most suitable source is a powerful mercury arc lamp of the type used in street lighting. This should be enclosed in a box of suitable size which is provided with an exit window of sufficient area for the emergence of the light. A glass cell containing cuprammonium solution which covers the exit aperture makes an effective filter. It transmits the λ 4358 radiations and cuts out all longer wavelengths. The light emerging through the filter may be received on a ground-glass screen, the observations being made on the light emerging through it. Alternatively, the light may be received on an opaque diffusing screen, the surface of the latter being viewed by the observer at any convenient angle. This, of course, is a much less efficient source of light than the ground-glass screen which operates by transmission. No colour filter is necessary in either case, only the polaroid being held by the observer before his eye. By varying the distance of the ground-glass sheet or of the diffusing screen from the exit-aperture of the source, a very wide range of strength of the illumination may be obtained.

Results of the Investigation.—When the techniques of observation described above are made use of, it becomes immediately apparent that the perception of polarisation is only possible when the source under observation has a fairly high luminosity and that it becomes more and more difficult as the luminosity of the source is progressively diminished. Finally, a limit is reached below which the phenomenon cannot be observed at all. The progressive deterioration in visibility is the result of a diminishing contrast between the luminosities of the dark and the bright brushes seen in the field of view

of the polaroid. A stage is reached when by reason of such diminishing contrast, the brushes are barely perceptible and finally become altogether invisible.

The observations made using the λ 4358 light of the mercury arc in the manner described above make it clear that the falling off in the visibility of the brushes as seen through the polaroid takes place in the same range of luminosities of the field as the progressive weakening of the chromaticity and the diminution in visual acuity described and discussed in the earlier chapters of this work. The parallelism between these phenomena is close and may indeed be described as a semi-quantitative relationship. That the perception of polarisation belongs to the same category as the perception of form and the perception of colour is thereby clearly established.

We may now sum up the observations described above and the conclusions which have resulted in the following series of propositions :
I. The perception of the polarisation of light in a luminous field is limited to the blue-violet sector of the spectrum, *viz.*, the wavelength range between 400 mμ and 500 mμ. II. The perception takes the form of two crossed brushes which are bright and dark respectively, the bright brush running parallel to the direction of vibration in the polarised light, and the dark brush transverse to that direction. III. The brushes appear in the field of view which corresponds to the location of the fovea in the retina. They rotate with the plane of polarisation when the latter is rotated. IV. The contrast in luminosity between the bright and dark brushes diminishes till they finally become invisible when the luminosity of the field is diminished progressively to a low level. V. There is a complete parallelism between the behaviour just described and the weakening in chromaticity and the fall of visual acuity in the blue-violet region of the spectrum which accompanies a diminishing strength of illumination. VI. The perception of polarisation thus emerges as an integral part of the same visual process which makes the perceptions of light, form and colour possible in the blue-violet sector of the spectrum. VII. The materials present in the fovea which activate the perception of light in the blue-violet part of the spectrum are disposed with a high degree of radial symmetry around the centre of the fovea.

In the succeeding chapter, we shall return to a more detailed consideration of the results stated in these propositions.

HIGH ENERGY PHYSICS

B. M. UDGAONKAR

Tata Institute of Fundamental Research, Bombay

THE Twelfth International Conference on High Energy Physics was held at Dubna, U.S.S.R., from August 5 to August 15, 1964. The following is a brief survey of some of the interesting recent developments in particle physics against the background of this Conference.

Perhaps the most interesting new development reported at this Conference was the work of the Princeton group consisting of Christenson, Cronin, Fitch and Turlay. They announced the discovery of the 2π decay mode of K_2°, indicating a violation of CP invariance. They had over forty events of the type $K_2^\circ \rightarrow \pi^+ + \pi^-$, giving a branching ratio

$$\frac{K_2^\circ \rightarrow \pi^+ + \pi^-}{K_2^\circ \rightarrow \text{all charged modes}} \simeq 2 \cdot 0 \pm 0 \cdot 4 \times 10^{-3}.$$

Some additional experimental evidence in support of this observation was reported by an Illinois group. Various attempts have been made to maintain CP in spite of this observation, *e.g.*, one has raised the question as to whether unstable particles do really decay exponentially over time intervals that are very long compared to the mean lifetime, *e.g.*, if the decay rate of K_1° at large t is slower than the exponential rate valid at relatively small t, one might have a long-lived K_1° component interfering with the observation of K_2°. Another suggestion (Okun) is that K_2° may sometimes decay first into an as yet unobserved heavy neutral lepton X° of mass $\simeq 480$ MeV ($K_2^\circ \rightarrow X^\circ + \nu$) and that this X° then decays according to $X^\circ \rightarrow \pi^\mp + \mu^\pm$, the $\mu^\pm$ being mistaken for a $\pi^\pm$. Some authors (*e.g.*, Bernstein, Cabibbo and Lee) have invoked a new kind of long-range vector interaction in order to explain the experimental observation. In a somewhat similar fashion, Lévy and Nauenberg have hypothesized the existence of a new extremely light neutral vector boson s of mass smaller than the $K_1^\circ - K_2^\circ$ mass difference, so that the decay $K_2^\circ \rightarrow K_1^\circ + s$ is possible. (Incidentally, one does not yet know definitely whether K_2° is heavier than K_1° or *vice versa*, though such experimental evidence as exists favours the former alternative.) This suggestion is reminiscent of the proposal for the existence of the neutrino, which was made to save angular momentum conservation in β-decay. The reasons do not, however, appear to be as compelling,

and it seems best to take the experimental observation at its face value as implying CP violation.

If this interpretation is correct, several questions arise. Is CPT still valid ? If so, there must be a violation of time-reversal invariance, and in that case another time-honoured invariance principle will have been thrown overboard, in so far as weak interactions are concerned. One will of course search for other independent tests of both CP and T invariance in various weak interactions. There is also the possibility that it is CPT, and not necessarily T, that is violated. But then it is not clear how one could ensure the exact equality of the masses and lifetimes of particles and antiparticles. One may therefore ask if the masses and lifetimes of particles and antiparticles are indeed exactly equal, and so it is desirable to have more accurate experiments to test these equalities. Another very pertinent question is whether the small branching ratio for the 2π decay mode of K_2° implies a small or a large violation of CP. One asks this because one has been accustomed to a large violation of C and P, when they are violated at all. A note of caution is however sounded by Cabibbo who reminds us that non-leptonic decays of strange particles are not at all well understood, and that the decay $\Sigma^- \rightarrow n + \pi^-$ is nearly parity conserving. In any case, Sachs has suggested that the experimentally observed small branching ratio may be an indirect manifestation of a maximal CP violation in the leptonic interactions of K°. Such a leptonic mechanism, however, requires that the $\Delta S = \Delta Q$ rule be strongly violated too. In fact, "maximal violation" is then defined by the statement that the $\Delta S = - \Delta Q$ interaction is out of phase with the $\Delta S = \Delta Q$ interaction by $\pi/2$. Though there was supposed to be a substantial evidence in favour of a violation of the $\Delta S = \Delta Q$ rule a couple of years ago, more recent experiments are consistent with a rather small violation of this rule, and therefore the suggestion of Sachs does not seem to be in the right direction. Instead, Cabibbo proposes a modification of the non-leptonic part of the current, and suggests that the so-called second-class currents, usually supposed to be absent, are in fact present and are CP violating. One then gets a CP or T violation which is small

for ordinary β-decay, including neutron decay, purely for kinematic reasons. To observe other T-violating effects one then has to study high Q-value β-decays, e.g., β-decays of hyperons or K-mesons, or μ-capture, or high-energy neutrino interactions. Another interesting suggestion is that of Amati and of Truong, that only the $|\triangle T| = 3/2$ part of the decay interaction is CP-violating. It should be possible to test this suggestion by measuring the branching ratio

$$\frac{K_2{}^\circ \rightarrow \pi^+ + \pi^-}{K_2{}^\circ \rightarrow \pi^\circ + \pi^\circ}.$$

One may remark on the 'philosophical' implications of CP violation. The overthrow of parity a few years ago came as a shock to many, to whom it was obvious on general grounds that there must exist mirror reflection symmetry in nature. It was possible to absorb this shock by following the suggestion of Landau and of Lee and Yang, that one may still have an extended mirror reflection symmetry in which 'particle reflection' or charge conjugation is carried out along with space reflection. This was the reason for the interest in CP invariance. Thus one proposed that there was a symmetry between the decay of a particle in one co-ordinate system and that of its antiparticle in the mirror system. Now if CP goes, and even if CPT is still valid, would one still insist that there is an extended symmetry with respect to mirror reflections?

Before leaving weak interactions we must refer to another dominant theme in the current discussions of weak interactions, namely the introduction of the SU (3) idea into the theories of weak decays. Here Cabibbo's theory has been remarkably successful, especially in removing some of the difficulties in the way of Universal Fermi Interaction, presented by the leptonic hyperon decays. There is, however, no satisfactory understanding of the Cabibbo angle. We may also summarize the present status of some of the other conservation laws and selection rules that have served to bring order into the large body of experimental information in this field. μ-e universality continues to be fulfilled in leptonic decays of pions, K-mesons and hyperons. The conserved vector current hypothesis has been borne out by several experiments specially designed to test it. Doubts had been raised about the validity of the $\triangle S = \triangle Q$ and $|\triangle T| = 1/2$ rules at the time of the last conference, but more recent experiments have shown that there are no marked departures from these rules. One still does not have a satisfactory understanding of the $|\triangle T| = 1/2$ rule. On

the current-current hypothesis, it can be understood rigorously only if one adds to the usual charged lepton currents some additional currents. The other possibility is that only charged currents are involved, but the $|\triangle T| = 1/2$ part of the interaction is somehow enhanced by strong interaction effects, i.e., the rule depends on the dynamics of the decay processes. Along these lines, and within the framework of SU (3), Dashen, Frautschi, Gell-Mann and Hara have proposed an octet enhancement model, and have discussed ways in which the two possibilities may be distinguished experimentally. It may be mentioned here that fresh limits have been put on neutral currents by recent experiments on the branching ratios of K^+ : there is no event of the type $K^+ \rightarrow \pi^+ + e^+ + e^-$, implying that $\frac{\text{neutral currents}}{\text{charged currents}} \lesssim 2 \times 10^{-5}$.

The intermediate vector boson continues to elude detection, and the present lower limit on its mass is 1·6 BeV.

During the last few years there has been a very substantial increase in the experimental information available on high energy scattering, thanks to the impetus provided by the predictions based on simple applications of the idea of Regge poles. It may be appropriate to list some of the questions about which one has been worried with regard to high energy cross-sections during the last few years : (1) What is the behaviour of σ_{tot} as $E \rightarrow \infty$? Do they really tend to a constant value as $E \rightarrow \infty$ as assumed by Pomeranchuk ? Have any of the total cross-sections, e.g., σ_{tot} (pp), really reached a constant value already ? (2) The Pomeranchuk Theorems : Do the cross-sections of particles and antiparticles, as well as of members of an isospin multiplet, tend to become equal as $E \rightarrow \infty$? If so, how do they approach equality ? (3) What is the behaviour of σ_{el} ? Does σ_{el}/σ_{tot} tend to a constant value as in several optical models, or does it tend to zero as in a simple Regge pole picture based on dominance of the Pomeranchuk Regge pole ? (4) Does Re f (o)/ Im f (o) tend to zero as $E \rightarrow \infty$, as has often been assumed in connection with the Pomeranchuk theorems ? (5) More strongly, does Re f (o) $\rightarrow$ 0 as $E \rightarrow \infty$, as has often been assumed on the basis of simple models of diffraction scattering ? (6) What is the shape of the diffraction peak ? Is it energy-dependent, in particular shrinking with energy, as first suggested by Regge pology, or is it energy-independent as was believed earlier ? (7) Is the contribution of spin-dependent terms really negligible at high

energies ? (8) More recently, there have appeared generalizations of Pomeranchuk theorems to differential cross-sections based on Phragmen-Lindelöf theorem. Are they obeyed by experimental cross-sections ?

The proton-proton total cross-sections were so far generally believed to be constant above 10 BeV, though analysis based on Regge poles had suggested that the constancy was only apparent, arising from the approximate cancellations of the contributions of different poles. At this Conference, however, Kycia from Brookhaven presented new and very accurate data (error $\sim 1\%$) on several total cross-sections, and showed that σ_{tot} (pp) is still falling slowly at 20 BeV. In fact, it falls by about 1·5 mb between 10 BeV and 20 BeV. σ_{tot} (K^-p) and σ_{tot} (K^+d), however, still seem to be constant in this energy interval. On the other hand, σ_{tot} $(\bar{p}p)$, σ_{tot} (π^+p), σ_{tot} (K^-p), σ_{tot} (K^-d), and σ_{tot} (np) are all falling in this energy range. It is clear, as has been emphasized again and again, that one has to be cautious in applying simple asymptotic formulæ in this region.

The π^-d and π^+d total cross-sections have been found to be equal all the way up to 20 BeV, thus providing a good verification of charge symmetry. Using these together with the π^-p and π^+p cross-sections measured by them, the BNL group has proceeded to test the Glauber formula for the screening of one nucleon by another in the deuteron. They find that the Glauber formula fits the measured π^+p, π^+d cross-sections very well, so that one can now apply it with confidence to find K^+n cross-section from K^+p, K^+d cross-sections and np, np cross-sections from pp, pd, and $\bar{p}p$, $\bar{p}d$ cross-sections respectively. It then turns out that the total cross-sections for np and pp cross each other at about 4 BeV, and that the np cross-section approaches the pp cross-section from above. This approach from above agrees with one's naive ideas about the repulsive character of the contribution of ρ_0 to pp scattering. On the other hand, the crossing of np and pp cross-sections at about 4 BeV means that the explanation provided by Muzinich for the sharp peak observed by Palevsky *et al.* in forward elastic charge exchange np scattering at 2·04 and 2·85 BeV/c. in terms of a single ρ Regge pole, cannot be right : these energies are just not high enough to apply single Regge pole expressions. Incidentally, there have been more recent experiments on np elastic charge exchange scattering at higher energies, and the sharp peak observed by Palevsky *et al.* is seen to persist.

One may at this point refer to the various particle exchange model proposed recently by several authors to account for the strong peaking in this reaction as well as in various other production reactions. The main feature of these models is that they avoid violation of unitarity in the low partial waves and include such final state interactions, usually as a kind of elastic scattering with a diffraction character. It is claimed that these corrections are capable of explaining the deviation from OPE primarily ascribed to phenomenological form factors. These models are, however, still rather crude, and it would be worthwhile to develop them further in view of the large mass of detailed experimental information that has now begun to be available on several production processes, especially on isobar production.

Accurate experiments on the angular distribution in the near-forward direction for πp and pp scattering have been pushed to very small angles, with the result that one now has a strong evidence for a substantial real part in the forward scattering amplitude of all these processes. The fact that the interference of this real part with the Coulomb scattering amplitude is constructive for πp and pp but destructive for $\pi^- p$ shows that the real part *corresponds to repulsion* in all these scatterings. The ratio $\mathrm{Re}\, f(0)/\mathrm{Im}\, f(0)$ seems to be of the order of 0·25 for all these scatterings and that in the region of ~ 10 BeV. One may add that the interpretation in the case of πp is unambiguous but that in the case of pp is not so unique since the data could also be interpreted in terms of a substantial spin-dependent part in the amplitude. Spin dependence is more over also indicated by the fact that polarization in pp scattering is dependent on energy. Lindenbaum believes, however, that $\mathrm{Re}\, f(0)$ in pp scattering is a real effect and not just an apparent effect arising from the spin dependence of the amplitude. If the present results persist, $\mathrm{Re}\, f(0)$ seems to be a slowly varying function of energy for both $\pi^+ p$ and pp.

The experimental results on the real part have been compared with forward dispersion relations by Söding and Levintov *et al.* for pp and by Barashenkov for πp. The agreement is reasonably good, but in view of the importance of such a comparison, one looks forward to a refinement of both the theoretical analysis and the experimental measurements.

There is no change in the situation with regard to the shrinkage of diffraction peaks except for the fact that there is now a substantial evidence

for an expansion of the diffraction pattern for p. pp and K^+p shrink. $\pi^\pm p$, K^-p do not shrink or shrink very little. The data could still be consistent with a model based on several Regge poles, but the comparison is no longer easy. In this connection one may mention a calculation by Igi which shows a strong energy dependence of the residue of the Pomeranchuk Regge pole.

There have been several attempts at empirical fits to the angular distributions at high energies. Guided by the optical model, Serber has suggested a scaling law for comparing the results for different incident particles. According to this scaling law, we are to compare the values of $\left[\dfrac{d\sigma}{dt}\middle/\left(\dfrac{d\sigma}{dt}\right)_0\right]$ as functions of the momentum transfer measured in dimensionless units: $t' = (\sigma_{tot}/4\pi)\, t$. In terms of this dimensionless quantity, angular distributions of pp and $\bar{p}p$ are virtually identical for small t' and so also those of $\pi^\pm p$ and $K^\pm p$. Another empirical attempt worth mentioning refers to large angle scattering outside the diffraction peak. The suggestion is to express the angular distribution in terms of $p_\perp$ instead of t, and was first made by Sankaranarayana and Sarma. This kind of fit has been carried out more recently by Kirsch and Orear and they claim that $ln\left(s\dfrac{d\sigma}{dt}\right) \propto p_\perp$ gives a straight line over a very large region—in which $d\sigma/dt$ changes by as many as ten decades.

The reason as to why $p_\perp$ should be the right variable in terms of which to discuss large angle scattering is not at all clear. Yang, in a letter to R. Wilson, has suggested a semi-classical picture in which the proton is regarded as an extended object, and the rapid drop of $d\sigma/d\Omega$ with $p_\perp$ is attributed to the difficulty of maintaining the proton intact in a scattering involving large transverse momentum transfer. In the same picture, eP scattering at large angles should drop roughly as fast as $\sqrt{(d\sigma/d\Omega)_{pp}}$ or the form factors G as $\sqrt[4]{(d\sigma/d\Omega)_{pp}}$. If one takes the right variable, *viz.*, total momentum transfer squared q^2, for describing this scattering, such a behaviour does not seem to be in violent disagreement with the Cornell data.

A by-product of the very accurate measurements on total cross-sections carried out by the BNL group has been the discovery of two more nucleon isobars, one in the $I = 1/2$ state at 2645 MeV and the other in the $I = 3/2$ state at 2825 MeV. These show up as tiny bumps with a height of only $0 \cdot 3$–$0 \cdot 4$ mb. in the total cross-section curves for $\pi^\pm p$. There is no sign of any new structure in the K^-p scattering, except

for a possible shoulder between 3 and 4 BeV/c. The bumps in total cross-sections being so small in this region, one would have to wait for them to show up in some specific reactions before being quite sure of their existence. In the meantime, of course, one has gone ahead to speculate about the Regge trajectories on which they should lie. In this way one gets impressive near-straight-line trajectories joining the four $T = 1/2$ particles lying at 933 MeV, 1688 MeV, 2190 MeV, and 2645 MeV, and the four $T = 3/2$ particles lying at 1236 MeV, 1924 MeV, 2360 MeV, 2825 MeV. What is even more striking is the fact that these two trajectories seem to more or less overlap each other.

As an experiment where one looks for a magnified effect produced by a small bump one may mention the work of Wahlig *et al.* These authors survey $\left(\dfrac{d\sigma}{d\Omega}\right)_{0^\circ}^{\text{CEX}}$, the forward differential elastic charge exchange cross-section for $\pi^- p$, over the range 2·4 BeV/c to 18 BeV/c. The charge exchange scattering amplitude is proportional to the difference between the $I = 3/2$ and $I = 1/2$ amplitudes. Making use of the optical theorem one has

$$\left(\dfrac{d\sigma}{d\Omega}\right)_{0^\circ}^{\text{CEX}} = \dfrac{1}{2}\left(D^- - D^+\right)^2 + \dfrac{1}{2}\left(\dfrac{k}{4\pi}\right)^2\left(\sigma^- - \sigma^+\right)^2$$

Since above 2·4 BeV/c, the difference $\sigma^- - \sigma^+$ is much smaller than the magnitude of each, the forward charge exchange cross-section should reflect resonances in this region with a much more favourable signal-to-noise ratio than would a total cross-section experiment.

The explosion in the population of resonances continues without any check in sight. The need for classifying them into multiplets on the basis of some symmetry scheme has therefore become all the more imperative. The SU (3) scheme has had some spectacular successes in this regard during the last couple of years. Here one thinks of the Gell-Mann Okubo mass formula, in particular for the spin 3/2+ baryon decuplet which led to the prediction and then the discovery of the Ω^-. Apart from this multiplet [which comprises of $N_{3/2}^*$ (1236), Y_1^* (1382), $\Xi_{1/2}^*$ (1529) and Ω^- (1675)], other known (or suspected) baryon multiplets are the spin 1/2+ octet (consisting of N, Λ, Σ, and Ξ), and the spin 3/2- octet [consisting of $N_{1/2}^*$ (1518), Y_1^* (1660), Y_0^* (1680), $\Xi_{1/2}^*$ (1810)]. It is remarkable that all the known baryons can be accommodated within these multiplets, a few singlets [namely Y_0^* (1405), Y_0^* (1520)], and their Regge recurrences. We have already listed the possible Regge recurrences of N and N* (1236),

Y_0^* (1815) could be a recurrence of Λ. There still remain a few baryons, whose existence has been suggested but not confirmed and which do not fall easily into the above pattern. In this category, the strongest candidate perhaps is the $1/2^+$ πN resonance at 1480 MeV, suggested by Roper. One watches with interest if this resonance, and a few others, do indeed establish themselves. There is also the $N_{5/2}^*$ (1560). Here an attractive suggestion due to Abers, Balázs and Hara is that the nucleon the $N_{3/2}^*$ (1236) and the $N_{5/2}^*$ (1560) are the first three members of a family of particles with $J = T = 1/2$, $3/2, 5/2, \ldots\ldots$

While the classification of the baryons is thus reasonably satisfactory, the same cannot yet be said about the bosons. So perhaps one has to wait for the discovery of a few more bosons before they also fall into definite patterns. And the experimentalists promise to be quite obliging. The well-established boson multiplets are the pseudoscalar octet (π, η, K, $\overline{K}$), and the vector octet and singlet which mix with each other (ρ, ω, K^*, $\overline{K}^*$ and ϕ). Among the bosons whose multiplet assignments are not yet known, one has f^0 (1250), B (1215), κ (725), A_1 (1080), A_2 (1310), $\eta 2\pi$ (960), which are fairly well established, and a host of other candidates which await further confirmation. One may remark in passing that B (which decays first into ω and π), A_1 and A_2 (which decay first into ρ and π) and $\eta 2\pi$ (as also $N_{5/2}^*$) are instances of cascade decays of resonances which would not show up in two-body scattering or in two-body final state interactions.

The success of the mass formula for the SU (3) multiplets mentioned above, as also for the electromagnetic mass differences (Coleman and Glashow), is quite impressive. One also notes the success of the sum rule involving the decay amplitudes for the $3/2^+$ resonances (V. Gupta and V. Singh; also C. Becchi, E. Eberle and G. Morpurgo). One does not really understand why all these relations work so well. The scheme has no outright failures. One of the reasons for this is that, unlike the many previous schemes which have failed, it does not have built into it any absolute selection rules that would forbid processes allowed by isospin and strangeness selection rules. Moreover, symmetry breaking terms (however ill-understood) are an integral part of the scheme.

The successes of SU (3) accentuate a puzzle which has existed since its inception, though one chose to ignore it in the beginning. Why is it that nature does not make use of triplets?

Or can it be that triplets do indeed exist but may have so far eluded detection? A revolutionary suggestion incorporating triplets, made independently by Gell-Mann and Zweig, endows them with fractional charges ($2e/3$, $- e/3$, where $- e$ is the charge of the electron) and a fractional baryon number. If they exist, they would constitute a new form of stable matter. There have been searches for these 'quarks' or 'aces', so far in vain. There are other alternative schemes involving triplets, which are conventional as far as charge or baryon number are concerned, but are endowed with a new quantum number C, which has been variously called 'triality', 'peculiarity', 'supercharge', 'charm', etc. For ordinary matter, $C = 0$. The triplets would then be stable, weakly decaying or strongly decaying, depending on the degree to which C is conserved. Schwartz has planned an experiment to look for possible stable triplets.

Encouraged by the successes of SU (3), several extensions to higher symmetries have been carried out and were reported at the Conference. The most interesting extension, however, seems to be the SU (6) scheme, which appeared after the Conference (Pais, Gursey and Radicatti; Bég and V. Singh).

Having seen that a particular symmetry scheme is so successful in providing a classification of the known particles, one naturally asks the question : what is the dynamics behind all this ? In other words, how does this symmetry arise ? and why not some other symmetry ? The idea of the so-called bootstrap mechanism promises to provide an answer to this question. The bootstrap idea arose through the early work of Chew and Mandelstam on $\pi\pi$ scattering, where they noticed that the exchange of a ρ-meson was capable of providing the force necessary for binding two pions into a ρ-meson. The idea has since developed into a philosophy in which all the strongly interacting particles—whether stable ones or resonances—are regarded as being on the same dynamical footing, each a composite of all possible ones, bound together by the forces due to the exchange of all possible particles, including itself. None is regarded as more elementary than the others. The idea has a very considerable æsthetic appeal, especially in the face of the rapidly increasing population of particles, and has met with semi-quantitative success in predicting the parameters of several of the low-lying particle states. It has also been applied to the problem of predicting the octet of vector boson resonances in the scattering of a pseudo-

scalar boson octet by itself, or of predicting the octet and the decuplet in meson baryon scattering, etc. Through this kind of work, initiated by Capps, Cutkosky, and Martin and Wali, one hopes to understand how symmetries arise, and how they are broken. The tools one uses in these investigations are the analyticity properties of the S-matrix, and general properties like unitarity and crossing symmetry. However, at present, one is forced to introduce very drastic simplifying approximations in carrying out the programme, even in single channel problems, and all the more so in the multi-channel problem relevant to the question of symmetries. The semi-quantitative success achieved so far has therefore been very encouraging, and has stimulated considerable activity in this field. If these attempts succeed, one will have travelled quite far from one's naive conception of what elementary particles are.

CHEMICAL COMPONENTS OF THE *LOBARIA* LICHENS FROM THE WESTERN HIMALAYAS

P. S. RAO, K. G. SARMA AND T. R. SESHADRI

Advanced Centre for Chemistry of Natural Products, University of Delhi, Delhi-6

AMONG lichens, members of the genus *Lobaria* are generally found in abundance on the Himalayas at altitudes above 8,000 ft. They are foliose, fairly large in size and are readily recognised by the presence of white spots on a dark violet background when dry and olive-green when moist. They have been considered to be important in perfumery and tanning and have been used as vegetable drugs for the cure of eczema and for lung troubles.

In an earlier investigation[1] of the lichen *Lobaria isidiosa* from Darjeeling, it was found to contain a triterpene and thelephoric acid, a

these cases have been compared with the above four terpenoids.

Lobaria isidiosa

Of the two samples of *L. isidiosa* now examined, one was collected near Darjeeling (8,000 ft.) during the summer of 1961 while the other was collected in June 1962 from a pine tree near Ganghariya (10,000 ft.) in Western Himalayas. The general extraction procedure adopted was the same as described by Aghoramurthy *et al.*[4] The results are presented in Table I, and the details of separation and identification are given below.

TABLE I
Chemical components of L. isidiosa

Year and place of collection	Petroleum extract (Yield %)		Ether extract		Acetone extract
1961 Darjeeling	.. Wax and carotenoids	(i)	Triterpene (D) (0·57%)	(i)	Thelephoric acid (0·23%)
		(ii)	Stictic acid (0·38%)	(ii)	Stictic acid (0·51%)
				(iii)	D-Mannitol (0·20%)
1962 Ganghariya	.. ,,	(i)	Triterpene (D) (0·40%)	(i)	Thelephoric acid (0·17%)
		(ii)	Stictic acid (0·28%)	(ii)	Stictic acid (0·24%)
				(iii)	D-Arabitol (0·17%)

dark violet quinone pigment. Aghoramurthy, Sarma and Seshadri[2] used this lichen as a source of thelephoric acid for a detailed study of its constitution. Samples collected during the summers of 1953, 1958 and 1959 showed variation in their chemical components.[3] The presence of fairly good amounts of terpenoid compounds was noted in this lichen and four terpenoids A, B, C and D were recorded. This prompted us to study other samples of this and other *Lobaria* species collected mainly from the Western Himalayas. The terpenes isolated in

Petroleum ether extract was concentrated and chromatographed on alumina. Elution with various solvents gave only wax and carotenoids with both lichen samples.

Ether extract was evaporated to dryness. Preliminary examination showed that it consisted of a phenolic and a non-phenolic compound separable with 80% acetone. Hence the mixture was repeatedly extracted with boiling 80% acetone. The extract on concentration yielded a colourless solid which on repeated crystallisation from 80% acetone gave stictic

acid, m.p. and mixed m.p. 267–69° d.; tetra-acetate, m.p. 226–27°. The acetone insoluble residue was colourless and non-phenolic. It was sparingly soluble in alcohol, ether, benzene and chloroform and readily in pyridine. It crystallised from boiling glacial acetic acid as colourless needles, m.p. 289–91°, $[a]_D + 21°$ (C, 1·0 in pyridine). It gave a pink colour in the Liebermann-Burchard test and analysed for $C_{31}H_{50}O_5$. That it is a terpenoid hydroxy acid was shown by the preparation of its acetate, m.p. 286–88°, and its methyl ester, m.p. 244–46° which gave yellow colour with tetra-nitromethane in chloroform indicating unsatura-tion. Agarwal et al.[3] reported the presence of a triterpene (compound-D) m.p. 267–69° from L. isidiosa collected from Darjeeling in 1959; crystallisation of this compound twice from glacial acetic acid raised the m.p. to 289–91°; methyl ester, m.p. 244–46°. A direct comparison of the two samples and their methyl esters con-firmed their identity.

Acetone extract was concentrated and the dark violet solid was filtered off. It was extracted exhaustively with 80% acetone and

pentoxide crystallised from dry methanol-ether mixture. The first lichen sample gave D-man-nitol, m.p. 162–64° (hexaacetate, m.p. 122–24°) while the second yielded D-arabitol, m.p. 101–02° (pentaacetate, m.p. 76°). The mother liquors in each case did not show the presence of any second alcohol.

Lobaria retigera

Morphologically both L. isidiosa and L. reti-gera look alike except that the latter is much darker on its reverse side than the former. A Japanese sample of L. retigera was earlier examined by Asahina et al.,[5] who obtained thelephoric acid (0·013%) along with a colour-less unknown acid. Indian samples have not been examined earlier. Four collections were made from the following places during the sum-mer of 1962: (1) Valley of flowers (12,500 ft.), under the 'Rutba' plants. (2) Ganghariya (10,000 ft.), from rocks. (3) Ganghariya, from the pine trees and (4) On the way to Hemkund-Lokpal (13,500 ft.) under the 'Rutba' plants. The method of extraction was the same as for L. isidiosa and the compounds and their yields are recorded in Table II.

TABLE II

Chemical components of L. retigera *collected during June, 1962*

Place of collection	Petroleum ether extract	Ether extract	Acetone extract
Valley of flowers ..	Wax, carotenes and triterpene-(A) (0·011%)	(i) Triterpene (D) (0·46%) (ii) Thelephoric acid (0·065%)	(i) Thelephoric acid (0·22%) (ii) Stictic acid (0·34%) (iii) D-Mannitol (0·46%) (iv) Arabitol*
Ganghariya (from Rocks)	(i) Triterpene-(A) (0·27%) (ii) Terpenoid acid-(B) (2·4%)	Triterpene-(D) (0·03%)	(i) Thelephoric acid (0·19%) (ii) Stictic acid (0·11%) (iii) D-Arabitol (0·17%) (iv) Mannitol*
Ganghariya (from pine trees)	(i) Triterpene-(A) (0·059%) (ii) Terpenoid acid (B)-(0·47%)	Stictic acid (1·0%)	(i) Thelephoric acid (0·18%) (ii) Stictic acid (0·53%) (iii) D-Arabitol (0·53%) (iv) Mannitol*
Hemkund Lokpal	(i) Triterpene-(A) (0·29%) (ii) Terpenoid acid-(B)(2·75%)	Triterpene-(D) (0·057%)	(i) Thelephoric acid (0·29%) (ii) Stictic acid (0·043%) (iii) Arabitol*

* Compounds identified paper chromatographically.

the residue crystallised from hot pyridine to yield brilliant dark violet crystals, not melting below 360°, identified as thelephoric acid by direct comparison with authentic sample.

The combined filtrate was evaporated to dryness and the residue extracted with hot water. The insoluble part on crystallisation from 80% acetone gave stictic acid, m.p. and mixed m.p. 267–69° d. The water extract was concentrated on a water-bath to get a syrupy liquid which after drying over phosphorous

Light petroleum extract of sample 1 was concentrated and chromatographed on alumina. Elution with different solvents gave wax, carotenoids and a colourless substance (A). The extracts of samples 2, 3 and 4 were con-centrated and left overnight whereby (A) separated as a colourless solid. The mother liquor on further concentration gave another colourless crystalline solid (B).

(A) crystallised from chloroform as colour-less prisms, m.p. 270–73°, $[a]_D + 28°$ (C, 0·5 in

chloroform). Colour reactions indicated it to be a saturated triterpene, $C_{30}H_{52}O_2$. That it is a diol was shown by the preparation of its diacetate, m.p. 276–79° and dibenzoate, m.p. 304–06°. It was identified as triterpene (Compound-A) earlier obtained by Agarwal et al.[3] from *L. isidiosa* by direct comparison.

(B) crystallised from dioxan-acetone as colourless long needles, m.p. 218–21°, $[\alpha]_D - 59$° (C, 1·0 in chloroform). It was non-phenolic and gave an orange red colour with a green fluorescence in the Liebermann-Burchard test. That it is an $\alpha\beta$-unsaturated carboxylic acid was shown by its I.R. spectrum (ν_{max} 1667 cm.$^{-1}$) and U.V. absorption (λ_{max} 239 mμ; log ϵ: 3·92). It was identical with the "Compound-B" described by Agarwal et al.[3]

Ether extract of smaple 1 on evaporation gave a light violet mixture of thelephoric acid and a triterpene acid. Separation was effected taking advantage of the fact that thelephoric acid forms a blue-coloured water soluble complex with borax. The mixture was macerated with a concentrated solution of borax, the suspension filtered and the colourless residue washed with borax solution and water. The residue gave colour reactions of triterpenes and crystallised from glacial acetic acid as colourless needles, m.p. 289–91°. Its identity with the triterpene (D) obtained earlier from *L. isidiosa* was shown by mixed fusion and the identity of I.R. spectra; their methyl esters were also found to be identical. The borax solution of the thelephoric acid on acidification deposited the acid as a

blue powder. Samples 2 and 4 also gave only compound-D from their ether extracts and no thelephoric acid whereas sample 3 did not give (D) and gave only stictic acid.

Acetone extract was studied in the same way as in the case of *L. isidiosa* and it gave thelephoric acid, stictic acid, D-arabitol and D-mannitol in all the four samples. Of the two sugar alcohols, only one could be isolated in each case while the presence of the other was detected by paper chromatography.

As will be clear from Tables I and II, there is general resemblance in the phenolic components of the various *Lobaria* samples examined but there are variations in the terpenoid components. Compound (A) is a diol, compound (B) an $\alpha\beta$-unsaturated terpenoid acid and compound (D) is an unsaturated triterpene acid. It may be mentioned that the triterpene acid (Compound-C), m.p. 318–20°, reported by Agarwal et al.[3] from *L. isidiosa* has not been detected in the course of the present work. A detailed study of the compounds (A), (B) and (D) is in progress.

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RAMAN SPECTRUM OF GALLIUM PHOSPHIDE

RECENTLY considerable interest has been shown in the interpretation of the infra-red lattice absorption of crystals in terms of two-phonon interactions. A method of obtaining complementary information on the subject is to study the Raman scattering in typical crystals involving two-phonon processes. Results of such a study on the Raman spectra of gallium phosphide, using the 6328 Å output of a helium-neon laser have been reported. This is the first time that a Raman spectrum has been measured for a III-V semiconductor. So far no Raman measurements have been made on III-V semiconductors because of the lack of suitable sources with photon energies less than the band gap of the semiconductor.

The sample was a zone-refined polycrystal of good optical quality. The laser beam of the He-Ne laser with a uniphase output of 30 mW

c.w. was passed vertically through the gallium phosphide crystal, and the light scattered at right angles was examined with a $f/6$ Hilger and Watts Raman spectrograph.

In the Raman scattering process the first-order spectrum, which involves the creation or destruction of single phonons, is not so strong, does not obscure the two-phonon spectrum, and establishes the energies of the longitudinal (LO) and transverse (TO) optic branches at the centre of the zone. An analysis of the second-order Raman spectrum shows a number of lines which have been assigned to two-phonon interactions. Two prominent peaks at 782 cm.$^{-1}$ and 736 cm.$^{-1}$ correspond to the optical phonon energies of 391 cm.$^{-1}$ (TO) and 368 cm.$^{-1}$ (LO) at the zone centre.—[*Physics Letters* (Amsterdam), 1 November 1964.]

LETTERS TO THE EDITOR

VIBRATIONAL SPECTRA OF SOME TERTIARY AMIDES

MIYAZAWA *et al.*,[1] VENKATA RAMIAH AND VENKATA CHALAPATHI,[2] AND LUMLEY JONES,[3] recorded the Raman and infra-red spectra of some substituted amides and assigned the vibrational frequencies, but there appears to be no mention in literature about the vibrational frequencies of diethyl formamide and dimethyl benzamide. We report, in this work, the vibrational spectra, both Raman and infra-red, of diethyl formamide, dimethyl acetamide and dimethyl benzamide and the Raman spectra of these compounds in solution of water to assign the vibrational frequencies and study the variation in the frequencies of some of the Raman lines. The Raman spectra of these compounds have been obtained with a Fuess glass spectrograph with a dispersion of 19 Å/mm. in the λ 4358 region and a Hilger Raman Source Unit. The method of recording Raman spectra in solutions is the same as reported earlier. The infra-red spectra have been recorded with Perkin Elmer's Model 137 double beam Infracord with NaCl optics and using a drop of liquid pressed between two plates of NaCl. The Raman and infra-red frequencies and the estimates of their intensity in the conventional manner are given in Table I. The Raman spectrum of dimethyl formamide, obtained by the earlier workers,[4] is given for comparison.

TABLE I

Raman and infra-red spectra of tertiary amides (frequencies in cm.[1])

Dimethyl formamide		Diethyl formamide		Dimethyl acetamide		Dimethyl benzamide	
Raman	Infra-red	Raman	Infra-red	Raman	Infra-red	Raman	Infra-red
239 (2)	..	..	..	..	..	..	.
316 (3)	..	280 (4)	..	..	..	339 (5)	..
354 (4)	..	..	..	..	..	..	..
405 (4)	..	423 (2)	..	422 (3)	..	..	..
..	..	485 (1)	..	470 (2)	..	431 (2)	..
..	..	..	..	..	..	562 (2)	..
604 (0)	..	..	..	591 (4)	..	615 (5)	..
667 (6)	..	637 (5)	..	632 (2)	..	636 (2)	..
..	..	..	..	681 (2)	..	..	693 (m)
..	..	..	..	..	..	..	709 (st)
769 (0)	..	769 (4)	763 (w)	743 (7)	738 (w)	721 (4)	730 (st)
..	..	..	790 (w)	..	..	788 (2)	789 (st)
866 (6)	865 (w)	817 (3)	823 (st)	..	..	847 (1)	849 (w)
987 (5)	..	942 (2)	942 (m)	960 (4)	957 (w)	928 (2)	929 (m)
..	..	991 (2)	..	1016 (2)	1013 (st)	1003 (10)	..
..	1064 (w)	..	..	..	1029 (m)	1026 (3)	1020 (m)
1094 (4b)	1091 (st)	1085 (3)	1064 (st)	..	1054 (m)	1080 (2)	1076 (st)
1160 (2b)	1149 (vw)	1105 (3)	1107 (st)	..	..	1152 (2)	..
..	..	..	1209 (st)	1182 (3)	1183 (st)	1182 (2)	..
..	1256 (ms)	1257 (4)	1253 (st)	..	..	..	1208 (m)
..	..	1295 (0)	1297 (m)	1259 (3)	1259 (st)	1212 (4)	1256 (st)
..	..	..	1351 (sh)	1359 (2)	1351 (m)	..	..
..	1393 (st)	..	1375 (m)	..	..	..	..
1407 (6)	1404 (m)	1403 (2)	1408 (m)	1412 (5)	1395 (st)	1394 (5)	1381 (st)
1442 (6)	1443 (m)	1452 (6)	1425 (st)	1452 (5)	1440 (m)	1443 (6)	1431 (m)
..	..	..	..	..	..	..	1471 (w)
1487 (0)	1502 (m)	..	..	..	1494 (m)	1499 (2)	1493 (m)
..	..	..	..	..	..	1601 (5)	1567 (w)
1664 (4)	1681 (vs)	1665 (5)	1667 (vs)	1646 (6)	1653 (vs)	1626 (4)	1640 (vs)
2823 (3)	..	..	2780 (sh)	2822 (7)	..	..	2793 (w)
2873 (5)	2875 (ms)	2875 (5)	2865 (m)	2868 (4)	..	..	..
2945 (5)	2950 (m)	2940 (1)	2941 (sh)	2928 (6)	2941 (ms)	2931 (2)	2915 (ms)
..	..	2973 (4)	2967 (st)	3050 (3)	3003 (ms)	3051 (6)	3030 (m)

Note :—vs = very strong, st = strong, ms = medium strong, m = medium, w = weak and sh = shoulder.

The absorption band or Raman line in the region of 2950 cm.$^{-1}$ is assigned to the asymmetric stretching vibration of the methyl group attached to nitrogen and the corresponding symmetric stretch is in the region of 2870 cm.$^{-1}$ The frequencies in the region of 1400 cm.$^{-1}$ and 1440 cm.$^{-1}$ are respectively due to symmetric and asymmetric deformation modes of the CH$_3$ group while the rocking mode of the same group gives absorptions at 1091, 1064, 1054 and 1076 cm.$^{-1}$ in dimethyl formamide, diethyl formamide, dimethyl acetamide and dimethyl benzamide,

In primary and secondary amides, the intermolecular associations are of N—H- - -O=C type and therefore the vibrational frequencies of only the functional groups vary in the spectra of solutions of these compounds. The authors have recorded the Raman spectra of diethyl formamide, and dimethyl acetamide in solution of water. The Raman spectrum of dimethyl acetamide in solution of water is given in Fig. 1 and the shifts in some of the frequencies compared with those of the pure substance are indicated by arrows.
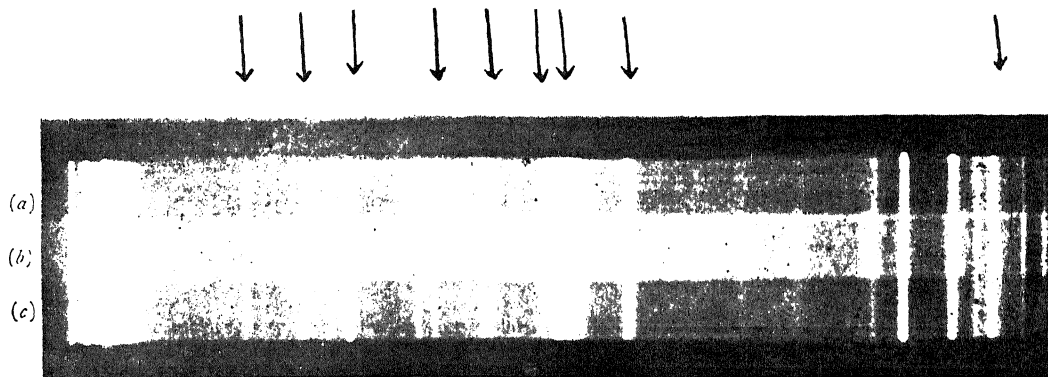
FIG. 1. (*a*) N Methyl acetamide. (*b*) N-Methyl acetamide in water. Ratio 1 : 2 by volume.

respectively. The bands at 2823 cm.$^{-1}$ in dimethyl formamide and at 2780 cm.$^{-1}$ in diethyl formamide are due to ν(C—H) and the bands at 1398 cm.$^{-1}$ and 1375 cm.$^{-1}$ in the same compounds are assigned to δ(C—H). The moderately strong absorption bands or Raman lines at about 1250 cm.$^{-1}$ are assigned to the asymmetric stretch of the

$$N{\displaystyle{\diagup CH_3 \atop \diagdown CH_3}}$$

group and the symmetric stretch of the same group gives absorption at 865 cm.$^{-1}$ in dimethyl formamide, 738 cm.$^{-1}$ in acetamide and at 730 cm.$^{-1}$ in dimethyl benzamide. It is of interest to note that the frequency ν(C = O) which occurs at 1681 cm.$^{-1}$ in the infra-red and at 1664 cm.$^{-1}$ in the Raman spectrum of dimethyl formamide decreases in the series dimethyl formamide, dimethyl acetamide and dimethyl benzamide. The Raman lines in the region of 667–591 cm.$^{-1}$ are assigned to the mode δ(OCN). The band at 960 cm.$^{-1}$ in dimethyl acetamide and the one at 928 cm.$^{-1}$ in dimethyl benzamide are due to the stretching vibrations of C—CH$_3$ and C—C$_6$H$_5$ respectively while the Raman lines at 470 cm.$^{-1}$ and 431 cm.$^{-1}$ in the same compounds may be due to δ(CCO).

Unlike in case of the corresponding primary and secondary amides, six Raman lines in the spectrum of diethyl formamide and nine in the spectrum of dimethyl acetamide show a variation in their frequencies. The diminution in the frequency of C=O stretch in solution of water is due to hydrogen bonding of C=O- - -H—O type ; this bonding has considerable secondary effects resulting in the variation of several vibrational frequencies.

Department of Physics,   V. VENKATA CHALAPATHI.
University College   K. VENKATA RAMIAH.
  of Science,
Osmania University,
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REDUCTION OF ACID PERMANGANATE BY METHANOL AND ETHANOL

THE kinetics of the oxidation of alcohols by various oxidants were studied by different workers. Bawn and White[1] studied the oxidation of methanol by Co(III) ion whereas the oxidation of methanol and ethanol by Ce(IV) ion was investigated systematically by Rao et al.[2] and Ardon[3] respectively. A search for literature showed that the reduction of permanganate by some alcohols[4,5] was also studied with a view to developing their new methods of estimations but their kinetics were not studied. The purpose of the present work was, therefore, to study the kinetics of the oxidation of alcohols by acid permanganate and some results have been recorded in this communication.

The materials employed were of the highest possible purity. Potassium permanganate was of E. Merck's grade and the solution was estimated by the iodometric method. The alcohols (L.R. variety) were purified by distillations.

followed the first order law with respect to the oxidant concentration.

In connection with their oxidations it might be mentioned that the reactions were studied up to aldehydic stage, i.e., consumption of 0·4 moles of the oxidant per mole of the substrate. The formation of HCHO and CH_3CHO in the cases of the oxidation of methanol and ethanol was tested. It was found that Mn(II) ion eliminated the induction period whereas fluoride ion greatly prolonged it. On the other hand, when trivalent manganese ion, i.e., Mn(III) was added, the oxidation of alcohols commenced immediately. It was, therefore, assumed that the trivalent manganese ion was the reacting species and the reaction may be explained on the basis of the mechanism proposed by Levesley and Waters.[6] It may be assumed that an initial activated complex was rapidly formed between the Mn(III) ion and the alcohol. The complex then disproportionated slowly and by the rate-determining step produced the alkoxy radicals.

TABLE I

No.	[Alcohol]	[KMnO₄]	pH	μ	Temp. °C.	K (min.⁻¹)
1	$3·974 \times 10^{-2}$ M	$12·31 \times 10^{-3}$ M	1·63	0·132	20	$2·763 \times 10^{-2}$
2	,,	,,	2·12	,,	,,	$2·073 \times 10^{-2}$
3	$2·208 \times 10^{-2}$ M	$10·25 \times 10^{-3}$ M	..	0·136	,,	$1·151 \times 10^{-2}$
4	,,	,,	..	0·152	,,	$0·6909 \times 10^{-2}$
5	,,	,,	..	0·168	,,	$0·4606 \times 10^{-2}$
6	$3·974 \times 10^{-2}$ M	$12·31 \times 10^{-3}$ M	1·22	0·132	31	$6·448 \times 10^{-2}$
7	,,	,,	,,	,,	25	$4·824 \times 10^{-2}$
8	,,	,,	,,	,,	20	$2·994 \times 10^{-2}$
9	$4·352 \times 10^{-3}$ M	$8·210 \times 10^{-3}$ M	1·42	0·108	,,	$5·984 \times 10^{-3}$
10	,,	,,	1·98	,,	,,	$5·501 \times 10^{-3}$
11	,,	,,	3·82	,,	,,	$3·684 \times 10^{-3}$
12	$8·704 \times 10^{-3}$ M	,,	1·72	0·124	,,	$4·606 \times 10^{-3}$
13	,,	,,	,,	0·140	,,	$4·030 \times 10^{-3}$
14	,,	,,	,,	0·156	,,	$2·878 \times 10^{-3}$
15	$4·352 \times 10^{-3}$ M	$2·121 \times 10^{-3}$ M	2·88	0·108	5	$1·842 \times 10^{-3}$
16	,,	,,	,,	,,	10	$2·187 \times 10^{-3}$

Experiments 1—8 and 9—16 denote the oxidation of Methanol and Ethanol respectively.

The reactions were carried out in a thermostat regulated to ± 0·5°. The ionic strengths of the solutions were maintained constant by the addition of requisite amounts of potassium sulphate to the solutions. The pH of the solution was adjusted by the addition of dilute sulphuric acid to the reaction mixture. In order to study the kinetics, alcohols and acid permanganate solutions were brought to the temperature of the thermostat and then rapidly mixed. Aliquot parts were withdrawn at suitable intervals of time and analysed for residual permanganate ion by the method mentioned previously. There was a period of disturbance in each case at the beginning of the reaction after which the rate

The alkoxy radical further reacted with Mn(III) and by very fast steps produced aldehydes.

The reactions were studied at different H⁺ and Mn(II) ion concentrations. As the concentration of H⁺ ion was increased, the rate of reaction also increased but Mn(II) retarded the rate of reaction. The activation energies were calculated from the plots of Log K vs. 1/T. The values were found to be 9·2 ± 0·5 and 11·5 ± 0·7 k. cals in the cases of the oxidation of methanol and ethanol respectively.

Dept. of Physical Chemistry,   J. BANERJEE.
University Colleges of   K. K. SENGUPTA.*
   Science and Technology,
92, Upper Circular Road,
Calcutta-9, *October* 21, 1964.

* Present address : Department of Chemistry, Royal Holloway College, Englefield Green. Surrey, England.

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LIQUID SCINTILLATION COUNTING OF ^{35}S LABELLED HYDROGEN SULPHIDE

DURING a study of the radiation chemistry of some inorganic sulphur compounds, it was observed that micro-quantities of hydrogen sulphide are produced, when gamma irradiated alkali thiosulphate[1] or tetrathionate[2] was dissolved in water. The gas was estimated by the methylene blue spectrophotometric method.[3] In an attempt to elucidate the mechanism of decomposition of the salts under radiation the 'outer' sulphur in these compounds was labelled with ^{35}S. Upon solution of the irradiated labelled compounds, the H_2S produced was found to be radioactive. The radio isotope ^{35}S is a soft β emitter of energy 0·167 Mev, with a half life of 87·1 days. A liquid scintillation technique was therefore followed to determine the amount of the radioactive gas produced.

MATERIALS

(i) *Labelled Compounds.*—Approximately 5 millicurie sample (in about a weight of 100 mg.) of 'outer' labelled sodium thiosulphate ($Na_2\overset{*}{S}SO_3$) was obtained from the Atomic Energy Commission of Canada Ltd. Assuming a 20% counting efficiency of the counter used, approximately 5 mg. of the active material was mixed with about 400 gm. of inactive $Na_2S_2O_3.5H_2O$ to give about 10^6 counts per min. per gram, and was recrystallised from aqueous solution.

Anhydrous $Na_2\overset{*}{S}SO_3$ was prepared from the pentahydrate, as described elsewhere.[4]

Sodium tetrathionate $Na_2S\overset{*}{S}\overset{*}{S}SO_6.2H_2O$ was prepared by the method given in Abegg's *Handbuch der Anoganschen Chemie.*[5]

(ii) Hyamine hydroxide [p-(diisobutyl-cressoxyethoxyethyl benzylammonium hydroxide)] used for absorbing the radioactive H_2S was obtained from Packard Instrument Co. Inc., Illinois, U.S.A.

Irradiation of the solid samples was carried out at room temperature ($25 \pm 5°$ C.) in the 'Gamma cell 220 CO^{60} Irradiation Unit' manufactured by the Atomic Energy Commission of Canada Ltd.

The counting of labelled samples was accomplished with a liquid scintillation counter supplied by Tracer Lab., Inc., Richmond, California, U.S.A. The scintillator was a solution of 5·3334 gm. of 2, 5-diphenyl oxazole (PPO) and 0·1333 gm. of 1, 4-bis-2-[(5-phenyl oxazolyl)] benzene (POPOP) in a litre of redistilled toluene.

To determine the initial activities of the labelled $Na_2\overset{*}{S}SO_3.5H_2O$, Na_2SSO_3 and $Na_2S\overset{*}{S}\overset{*}{S}SO_6.2H_2O$, about 10 mg. of each sample was accurately weighed and placed in a 20 ml. counting bottle of low potassium content. The bottle could be fitted with a bakelite screw cap. The solid was dissolved in 0·2 ml. of deaerated triple distilled water and the final counting solution made up to 20 ml. had the following composition by volume (Table I).

TABLE I

Component	Sodium thiosulphates	Sodium tetrathionate
Scintillator solution	75%	80%
95% ethanol	10%	..
Hyamine hydroxide	10%	10%
Re-distilled toluene	4%	9%
Water	1%	1%

The amount of alcohol, water and hyamine in the counting solution were kept constant, since they are known to quench the scintillations. Reproducible results could be obtained only when the solutions were cooled to — 10° C before counting. Solutions were counted to approximately a total of 10,000 counts,[6] to reduce the statistical deviation to $\pm$ 1%.

The apparatus used for generating H_2S from the irradiated compounds was similar to that of Budd and Bewick.[7] A known weight of the gamma irradiated salt was dissolved in deaerated triple distilled water in a reaction vessel, in an atmosphere of nitrogen. Pure and dry nitrogen was bubbled into the solution for 3-4 hours. The H_2S carried in the nitrogen stream was dried over calcium chloride and was absorbed in 2 ml. of hyamine hydroxide placed

in a U-tube. The hyamine solution was then transferred to a couunting bottle. It was made up to 20 ml. as given in Table I and the activity of H₂S was determined on the scintillation counter. The standard solution containing labelled thiosulphate or tetrathionate was counted at the same time. By knowing the specific activity of the standard in terms of counts per min. per micromole, the amount of H₂S was calculated, after making necessary corrections for the background. The results are summarised in Table II.

TABLE II

Compound	Time of irradiation (Hours)	H₂S yield	Micromoles/gm. of irradiated compound
		Spectrophotometric method	Scintillation method
Na₂S₂O₃·5H₂O ..	96	1·81 ± 0·01	1·58 ± 0·02
Na₂S₂O₃·5H₂O ..	192	3·65 ± 0·03	3·16 ± 0·04
Na₂S₂O₃ ..	96	0·59 ± 0·01	0·53 ± 0·01
Na₂S₄O₆·2H₂O ..	96	1·02 ± 0·01	1·04 ± 0·01

Yield of H₂S gamma irradiated thiosulphates and tetrathionate

It is observed from Table II that H₂S yields by the spectrophotometric method are slightly higher in case of thiosulphates. Experiments with mixtures of active benzoic acid $C_6H_5{}^{14}COOH$ and hyamine containing microquantities of inactive H₂S or sodium thiosulphate showed that the latter compounds had negligible quenching effect on the counting rate. The slight discrepancy in H₂S yields may be due to errors either in the radioactivity measurements or in the spectrophotometric method or in both. The maximum deviation observed in the calibration curve used in the spectrophotometric method was about ± 4%.

A Cary model 14 recording spectrophotometer was used to find the absorption maximum of methylene blue solution (670 mμ) and optical density measurements on the dye solutions were carried out on a Beckman DU spectrophotometer.

November 23, 1964.

D. S. MAHADEVAPPA.*
R. L. EAGER.‡

* Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore-12.
‡ Chemistry Department, University of Leeds, England.

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ISOLATION OF RAPANONE FROM ARDISIA MACROCARPA WALL.

EXTRACTION of the bark and hardwood of *Ardisia macrocarpa* first with petroleum ether or benzene resulted in the isolation of a yellow product (I) and subsequent extraction with acetone gave a colourless crystalline product (II).

Product (I) is yellow in colour, having a molecular formula $C_{19}H_{30}O_4$ and melted at 140–41°. It showed the reactions of a p-quinone in undergoing ready reduction and reoxidation. It formed a diacetate and a dibenzoate indicative of two phenolic hydroxyl groups. Reductive acetylation gave a dihydrotetraacetate. The existence of a p-quinone system was further supported by the formation of a violet dianil, a di-2, 4-dinitrophenylhydrazone, a disemicarbazone, a dioxime and a diphenylhydrazone. Hydrolysis of product (I) using aqueous alkali gave α-ketopalmitic acid which on further oxidation using alkaline hydrogen peroxide gave pentadeconic acid identified as its amide. From these considerations, product (I) is assigned the

(I)
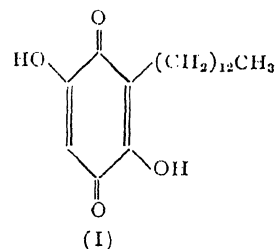
structure, 2, 5-dihydroxy-6-tridecyl-1, 4-benzo-quinone, possibly identical with rapanone.[1] Mixed melting point determinations with authentic samples of rapanone and the acetate of its reduction product, confirmed this identity.

(II)
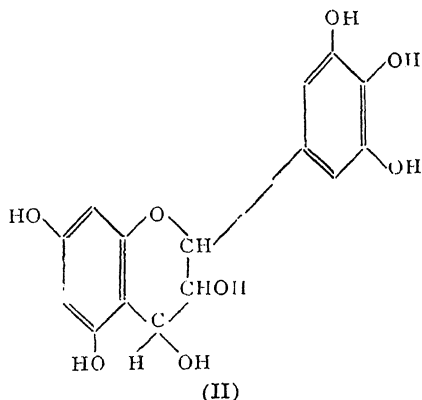
Product (II) analysed to $C_{15}H_{14}O_8$, $2H_2O$, melting above 300°, lævo ortatory, and formed a colourless heptaacetate, m.p. 228-30° d., a pentamethyl ether, m.p. 182-85°, $[a]_D^{39} = -50.5°$ and a pentamethyl-diacetate, m.p. 208-10° indicative of five phenolic and two alcoholic hydroxyl groups. It gave typical colour reactions of a leucoanthocyanidin, *viz.*, a blue ferric colour, a red colour or precipitate on warming with alcoholic hydrochloric acid and a cherry red colour with vanillin and hydrochloric acid in the cold. Oxidation of the pentamethyl ether with potassium permanganate gave trimethyl gallic acid, while oxidation with sodium metaperiodate showed the existence of a glycol system. The product was readily converted to delphinidin chloride. From these considerations, product (II) is assigned the structure, (—) 3, 4, 5, 7, 3′, 4′, 5′-heptahydroxyflavan, possibly identical with leucodelphinidin, isolated from Karada bark.[2]

Fuller details will be published elsewhere.

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PRECIPITATION OF COPPER-PHENYL PYRUVIC ACID OXIME COMPLEX FROM HOMOGENEOUS SOLUTION

THE technique of precipitation from homogeneous solution (PFHS) is being increasingly used in the field of analytical chemistry. Gordon[1,2] has shown that there is a striking difference between the physical characteristics of the precipitates obtained by conventional precipitation and those obtained by precipitation from homogeneous solution. The latter method yields precipitates of improved quality which are readily filterable and the adhering impurities are washed down easily. The precipitates obtained by this method do not clog a filter medium[3]; also reagent decomposition may be avoided.[4]

The authors have used phenyl pyruvic acid oxime (PPAO) for quantitative determination of copper.[5] In the present note, the precipitation of copper-oxime complex from homogeneous solution has been described. The precipitates obtained are dense as compared to those obtained by earlier methods[5] and are thus convenient to deal with. Also, washing the precipitates just two or three times was found to be sufficient.

Phenyl pyruvic acid (PPA) was synthesised by the method reported in literature.[6] Solutions of PPA and hydroxylamine hydrochloride (B.D.H.) of the strength $M \times 10^{-1}$ each were prepared by dissolving appropriate amounts in alcohol and distilled water respectively. Copper sulphate (A.R., B.D.H.) was used for preparing standard solution ($M \times 10^{-2}$) of copper. pHs of the solutions were adjusted with dilute solutions of sodium acetate and hydrochloric acid using a Metrohm pH meter, type E-350.

Procedure for determination of copper.—A standard solution of copper sulphate (3-30 mg.) was taken and diluted to about 40 ml. with distilled water. After adjusting pH of the solution between 2 and 5.5, solutions of hydroxylamine hyrochloride and PPA were added in ten times molar excess of the copper content of the solution. Precipitation commenced after about four minutes and the solutions were kept aside overnight after stirring. Copper thus precipitated as the complex (I),

(I)

was filtered through a sintered glass crucible No. 4 There was no need of digesting the precipitates on water-bath. The precipitates on the crucible were washed twice with 20% ethanol and dried at 110-15° C. in an oven. The results obtained are in conformity with those obtained by precipitation of the complex with PPAO.

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Department of Chemistry,   MOHAN KATYAL.
University of Delhi,   R. P. SINGH.
Delhi-7, *November 23, 1964.*

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ON THE USE OF ACYL SEMICARBAZIDE FOR THE SYNTHESIS OF ALDEHYDE

IN connection with a need for an aldehyde in the syntheses of *iso*-quinoline derivative that are being followed in this Institute, an attempt was made to utilise the reaction as developed by McFadyen and Stevens,[1] but by using N_1-acyl semicarbazide in place of benzene sulphonyl acly-hydrazine. A mixture of benzoyl hydrazine and urea in molecular proportions was heated under reflux for 10 hours in aqueous solution to give N_1-benzoyl semicarbazide, m.p. 226° (decomp.) on crystallisation from water (Found : N, 23·1% ; $C_8H_9O_2N_3$ requires, N, 23·4%). In a similar way several other acyl semicarbazides have been prepared (*cf.* Guha[2]) from p-chlorobenzoyl, anisoyl-, *iso*-nicotinoyl- and 1 : 3-dimethyl 3 : 4-dihydro-*iso*-quinoline-3-carboxy hydrazines and the respective melting points of the corresponding semicarbazides are 225–26°, 226–27°, 244–45° (decomp.) and 193–94°,

The benzoyl-semicarbazide (9 gm.) when heated with sodium carbonate (11 gm.) gave an oil, b.p. 178-79°, whose 2 : 4-dinitrophenyl hydrazone crystallises from ethyl acetate in orange yellow needles, m.p. 235-36°, not depressed when admixed with an authentic sample of 2:4-dinitrophenyl hydrazone of benzaldehyde. (Found : N, 19·05% ; $C_{13}H_{11}O_4N_4$ requires N, 19·5%).

In using urethane in place of urea a different type of reaction was noticed. Thus, for example, when *iso*-nicotinoyl hydrazine was heated with urethane on a wiregauze furnished 2-(4'-pyridyl)-1, 3 4-oxadiazole-5-one, m.p. 266-68° (decomp.) (Found : N, 25·51 ; $C_7H_5N_3O_2$ requires N, 25·77%). The properties of the compound agree in all respects with those of the similar product from *iso*-nicotinoyl hydrazine and carbonyl chloride (*cf.* Smith[3]). The work is in progress.

Bengal Immunity   SAKTI PADA DUTTA.
   Research Institute,   BIJAN PRASUN DAS.
Calcutta-16,   U. P. BASU.
November 23, 1964.

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2', 3', 4'-TRIHYDROXYCHALCONE AS AN ANALYTICAL REAGENT

LENSE et al.[1] examined the reactions of metallic ions with chalcones and reported that they are more sensitive than the aldehydes and ketones from which they are prepared. Tokuichi Tsumaki et al.[2] investigated the reactions of 4-chloro-2'-hydroxychalcone and 2, 2'-dihydroxychalcone with copper acetate in alcohol medium and obtained dark yellowish orange needles and dark yellow needles respectively. These complexes are shown to be of definite chemical composition. Gy Almassy et al.[3] reported on the use of 2'-hydroxy-4-nitrochalcone in microanalysis for the direct determination of alkaline earth metals. These authors reported that this reagent yielded precipitates exclusively with divalent metals and that the three functional groups present in it were involved in complex formation. Saiyad et al.[4] reported that 2', 4'-dihydroxychalcone yielded an intense reddish brown color with ferric iron. The present author[5] carried out spectrophotometric investigation on the color reaction and estab-

lished that the composition of the complex formed with Fe(III) was 1 : 3.

Among the chalcones under investigation by the present author it was found that 2′, 3′, 4′-tri-hpdroxychalcone gave a brown precipitate with 0.125γ of Cu(II) at a dilution of 1 in 4×10^5. An amperometric method of estimation carried out by the author[6] with this reagent yielded good results for 1.0–6.0 mg. of copper. Further investigations showed that this reagent was highly sensitive, though not equally specific, to several other di-, tri- and tetravalent metallic ions. Among the ions examined only uranyl (0.308γ) gave an orange color at pH 3.9–5.5 and at a dilution of 1 in 1.6×10^5. At a higher pH (5.7–8.4), however, an orange precipitate was obtained. In all other cases precipitates were obtained within the pH range given in Table I.

TABLE I

Metal ion	Colour	pH	Limit of Indentification γ	Limit of dilution
Cu++	Brown	3.8–4.5	0.125	4,00,000
Cd++	Dark brown	6.8–8.2	0.320	1,56,000
Pb++	Orange brown	3.9–5.9	1.250	40,000
Zn++	Orange	6.1–8.2	2.500	40,000
Ni++	Orange brown	5.8–6.4	0.154	1,62,000
Co++	Dark brown	6.3–8.0	2.500	20,000
Be++	Orange brown	5.0–6.7	0.256	3,89,700
Al+++	,,	4.7–5.0	0.320	1,56,000
Fe+++	Grey	2.6–5.3	0.200	2,50,000
La+++	Dark brown	5.4–7.5	1.000	50,000
Y+++	Orange red	4.7–6.6	0.800	162,400
In+++	Orange brown	3.1–4.0	0.312	1,60,300
Ti++++	Chocolate brown	1.5–2.5	0.0625	8,00,000
Th++++	Orange	3.7–4.4	3.000	16,600
Ge++++	Yellow	4.1–6.4	0.625	80,000

It is obvious that by controlling the pH range the selectivity of the reagent could be enhanced. The analytical applications of this reagent with the metallic ions are under investigation.

Department of Chemistry,   K. Syamasunder.
S.V. University, Tirupati,
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OCCURRENCE OF RAPAKIVI GRANITE IN SOUTH INDIA

FOR the first time, in South India is recorded an occurrence of rapakivi granite and grano-diorite at Manapparai (10° 36′ : 78° 26′), Tiru-chirapalli, Madras State. The outcrop covers an area of about five square miles. The rocks could be traced up to the village of Kudirai-kuttippatti, two and a half miles N. 30 W. of Manapparai and in the hill 950 west of the village. Outcrops are also noted round about Andavarkovil, a mile and a half north-east of Manapparai.

The rock mass is traversed by horizontal and vertical joints. The quarries that were opened in 950 hill have been abandoned, as the rocks easily crumble—a characteristic of the rapakivi granite which has earned for it the name rotten stone.

The rapakivi structures are conspicuously absent in the geologically associated rocks, outside the area referred to. The rapakivi granites are traversed by pegmatites and aplites parallel to and across the foliation.

Within the area the ovoids make their appearance at the contact with the granodiorites, which have developed a foliation. The rapakivi structure is typical. The ovoids of orthoclase microcline and perthite—varying in size from about one-fourth to a maximum of two inches—are surrounded by mantles of plagioclase (Ab_{70} An_{30}), wart-like intergrowths of vermicular quartz and plagioclase and hornblende. This ferromagnesian is observed in the microsections in parallel, subparallel and tangential positions to the potash felspar. The matrix also shows potash felspars and plagioclase besides hornblende and biotite. The felspars therefore occur in two generations.

Various views have been given for the genesis of the ovoids, which have been summarised by Read.

The magmatists hold that they are due to (*i*) crystallisation of drops of magma shed from the felspars (Holmquist); (*ii*) eutectic crystallisation of orthoclase and oligoclase (Vogt); (*iii*) refusion of the early formed orthoclase under conditions of reduction of gas pressure (Wahl.); (*iv*) a disturbed phase equilibrium in the crystallisation of the magma (Eckermann); (*v*) supersaturation of orthoclase and oligoclase alternatively (Harker); (*vi*) depletion of potash of the orthoclase—giving rise to oligoclase due to the potash being fixed up in biotite (Thomas and Cambell Smith); (*vii*) progressive con-

tamination of the magma and increase in its basicity (Wells and Woodridge).

The experimental work by Yoder, under 5,000 bars, and 720° C. support the igneous origin of the ovoids from a melt of nearly the same composition of potash and soda felspars and poor in lime.

peculiar granites, the following points deserve consideration :

    (*i*) quartzo-felspathic materials have the lowest melting points ;

    (*ii*) the felspars are often perthitic ;

    (*iii*) the rapakivi granites occur in localised areas in the country.
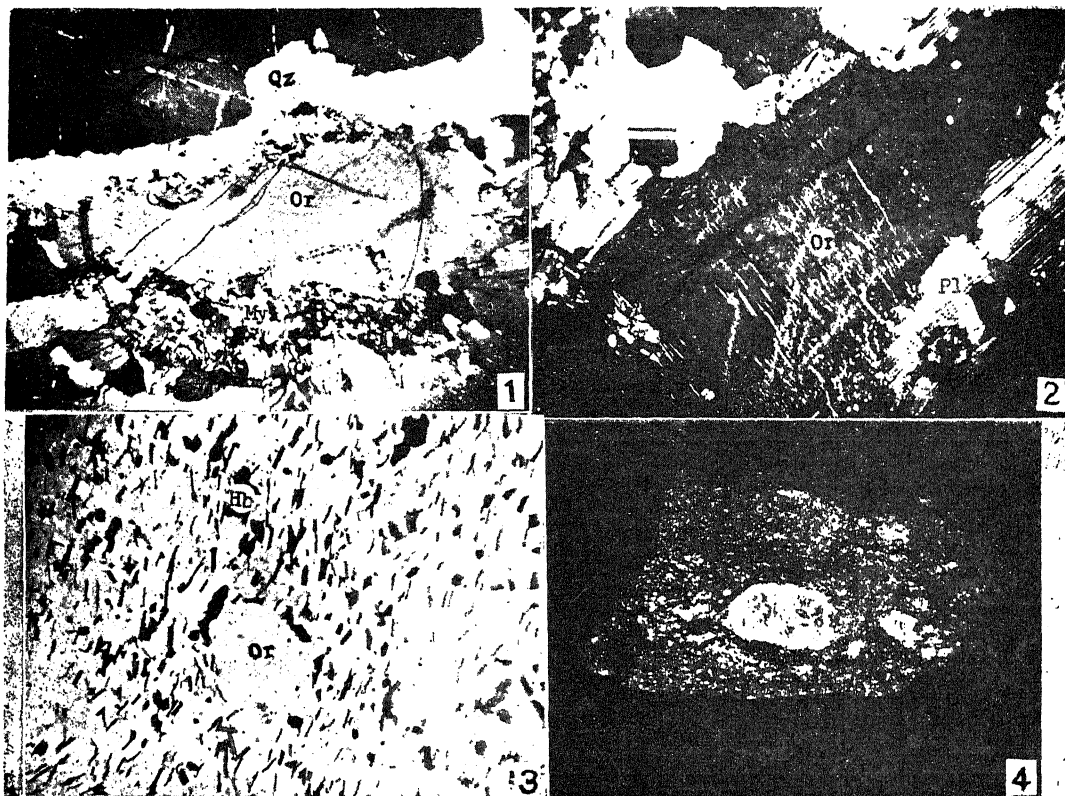
FIGS. 1-4   Fig. 1. Orthoclase (Or) surrounded by a rim of micropegmatite (My) and Quartz (Qz), × 30. Fig. 2.   Orthoclase perthitic (Or) surrounded by Plagioclase (Pl), × 30.   Fig. 3.   Hornblende (Hb) round Orthoclase (Or)—fluidal texture, × 30.   Fig. 4.   Plagioclase round, orthoclase (Hand specimen).

Chayes—from a statistical standpoint—has observed that certain rapakivi granites as those in Finland could not be explained by the theory of replacement.

The metamorphic school holds that "the rapakivi texture occurs in the agmatic front, around the syenetic mass" (Wegmann). Read accounts the formation of the rocks by felspathisation.

In the Manapparai area, field evidence in the form of chilled edges is lacking to support the magmatic view. Nor could one observe transition into unaltered rocks to support the metamorphic origin.

However in the interpretation of these

During the precambrian orogenic movements, the quartzo-felspathic material should have undergone liquefaction by anatexis, wherever the physical conditions were favourable.

The smaller grains of quartz and felspar would easily succumb to the heat leaving the bigger crystals partly fused at the outer layers. The calcium content in the perthites would go into solution in the regenerated magma. The liquid should have enveloped the bigger crystals of felspar and carried them along planes of weakness, to the accompaniment of hornblende. Thus a condition is postulated with a mobile mash of crystals of potash felspar and hornblende forcing its way upward along cracks and

fissures—the liquid medium being comparatively rich in calcium. Later crystallisation resulted in the formation of a mantle. This mantle may be oligoclase, or quasi-eutectic intergrowth of quartz and plagioclase or micro-pegmatite. The view is also supported by hornblende showing a flow movement, as revealed in its concentric arrangement round orthoclase and microcline. A rheomorphic origin is partly attributed to the rapakivi granites. The ovoid form is a legacy of the habit of felspar, which is elongated parallel to the a-axis or c-axis.

The field and laboratory studies are being continued to throw more light on the origin of the rapakivi granite of this area.

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PRELIMINARY STUDIES ON THE NODULATION OF ARID ZONE LEGUMES

It is well known that total nitrogen is very low in soils of the arid zone. Hence, symbiotically-fixed nitrogen is of great importance in improvement of soils and pastures. The grasslands of Rajasthan are notably poor in palatable leguminous species but weeds like *Tephrosia purpurea* and *Crotalaria burhia* are very abundant in fallow fields and wastelands. If these species could be induced to fix atmospheric nitrogen in large quantities, the soil fertility could be increased. As no data is available on the root nodules of arid zone species, preliminary studies were conducted at the Central Research Farm, Jodhpur, to investigate whether the indigenous species bear any nodules in their natural state.

Seeds of seven leguminous species, including *Phaseolus atropurpureus*, a Mexican-Australian hybrid species, obtained from the Division of Tropical Pastures, Brisbane, by the senior author were sown in the first week of August 1963, just after the first showers, in seven blocks of three rows each. The soils of the Farm are sandy loam in texture with a low water-holding capacity and a hard kankar pan at about 2 metres depth. The distance between the inter-rows and between the plants was kept at 1 and 2 metres respectively, to allow sufficient space for the development of the root system and for excavating it completely by a fine jet of spray according to the method of Upchurch.[2] The studies were conducted entirely under the normal environmental conditions and no attempts were made either to inoculate the soil or to control the moisture levels. The growth characteristics of shoot and root systems of the seven legumes were also recorded. The data are presented in Table I.

Fig. 1. Figure shows root nodules of *Phaseolus atropurpureus*, a hybrid species grown under ordinary conditions.

The results show that species like *Atylosia scaraboides*, *Rhyncosia minima* and *Tephrosia purpurea*, which have deep root systems, almost reaching the kankar pan are either devoid of root nodules or contain very few. It is significant to note that of the seven species studied, the greatest number of nodules (average of 57 per plant) was observed on *Phaseolus atropurpureus*, the exotic species. Its performance without the introduction of any specific rhizobia

TABLE I

Name of the species	Height of stem	No. of primary branches	Length of tap root	*No. and length of secondary roots	*No. and length of tertiary roots	*No. and length of rootlets	No. of nodules on tap root	No. of nodules on secondary roots	No. of nodules on tertiary roots	No. of nodules on rootlets	Total No. of nodules
	(cm.)		(cm.)	(cm.)	(cm.)	(cm.)					
1. *Atylosia scarabæides*	47·0	3	195·5	18–184 (8)	80–114 (12)	21–47† (71)	Nil	Nil	Nil	Nil	Nil
2. *Dolichos lablab*	37·5	2	123·0	36–139 (15)	24–60 (9)	5–21 (22)	Nil	3	4	Nil	7
3. *Phaseolus atropurpureus*	75·0	2	65·0	24–40 (13)	11–30 (7)	5–8 (11)	Nil	20	29	8	57
4. *Phaseolus aconitifolius*	67·0	10	68·0	29–59 (21)	15–23 (11)	8–11 (19)	Nil	22	Nil	Nil	22
5. *Rhyncosia minima*	38·0	4	174·0	45–57 (8)	15–26 (26)	14–39 (16)	Nil	Nil	Nil	Nil	Nil
6. *Tephrosia purpurea*	30·0	11	121·0	25–188 (5)	70–86 (11)	21–54 (77)	Nil	Nil	1	2	3
7. *Tephrosia tenuis*	25·0	4	177·0	12–122 (13)	46–48 (7)	5–9 (9)	Nil	Nil	3	4	7

* Figures in parenthesis are number of roots.   † The number of nodules is the average of three plants of each species.

and under the ordinary conditions of moisture and temperature, ranks it as a most useful species for large-scale introduction in the grasslands of Rajasthan. The experiments were conducted again in the monsoon of 1964 and confirmed the earlier findings. *Phaseolus aconitifolius*, which is largely cultivated in Western Rajasthan, bore 22 nodules per individual plant. Thus, nodulation is quite high in both species of *Phaseolus*, as compared to 15, 13, 14 and 22 nodules per plant of *P. trilobus*, *P. mungo*, *P. aureus* and *P. vulgaris*, as reported by Rangaswami and Oblisami[1]. Table I also shows that the root/shoot ratio is quite balanced in both species of *Phaseolus*, whereas in the others, the root system is three to four times, as long as the shoot system. Although, most of the species bore a few nodules on the tap roots in the initial stages (a fortnight after sowing), they soon disappeared, and nodulation was confined to the secondary and tertiary roots, at the time of flowering, when their root systems were excavated. Nodules disappeared from all the species after fruiting. Further studies are in progress with inoculation of specific rhizobia. The authors are grateful to Dr. P. C. Raheja, Director, for suggesting the problem, and for his guidance.

Central Arid Zone,   Y. SATYANARAYAN.
   Research Institute,   Y. D. GAUR.
Jodhpur, *October* 19, 1964.

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TOLERANCE OF THE PEA CRAB, *PINNOTHERES OSTREUM*, TO WATERS OF LOW SALINITY

THE pea crab, *Pinnotheres ostreum*, lives within the mantle cavity of the oyster, *Crassostrea virginica*, and causes considerable damage to the gills.[1] Christensen and McDermott[2] commented on the presence of gill lesions in oysters containing the pea crabs. Haven[3] stated that oysters with crabs contained less meat per unit of shell cavity volume than those without crabs. However, so far no one has investigated the tolerance of *Pinnotheres* to low salinity and determine the lethal salinity. It was therefore felt that a study of the tolerance of *Pinnotheres ostreum* to waters of low salinity would be of interest.

Specimens of *Pinnotheres ostreum* were collected from *Crassostrea virginica* which were grown on a commercial bed close to Gloucester Point, U.S.A., and the experiments were performed at Virginia Institute of Marine Sciences. Only females of Stage V were used for experimentation.[4] After obtaining the animals from the oysters, they were kept under running sea-water in the laboratory aquarium for at least 24 hours for acclimatization. Solutions of different salinities were made up by diluting sea-water with distilled water. One litre of solution was placed in each of the glass dishes. The salinities tested were 0·0, 0·3, 0·4, 0·5, 0·6, 0·7, 0·8, 1·0, 1·5% of NaCl besides normal aquarium sea-water whose salinity varied between 1·7

and 1·9% of NaCl. The temperature during the period of experiments ranged from 23·4 to 27·7° C. In almost all of the experiments 10 crabs were placed in each dish. The water in each dish was changed every day. The crabs were fed·on bits of prawns once in two days. Any mortality in each of the dilutions was. noted. The experiments were continued for 10 days.

All the experiments were repeated once and the results are given in Table I. The animals

TABLE I

Mortality of Pinnotheres ostreum *in different salinities*

Salinity expressed as per cent. of NaCl	Number of animals added initially	Number of animals dead on different days after starting the experiments									
		1	2	3	4	5	6	7	8	9	10
0·0	10	10	..	..	..	..	··	..	..	..	..
0·3	20	6	14	..	..	..	..	..	..	..	..
0·4	20	7	10	3	..	..	..	..	..	..	..
0·5	25	8	12	5	..	..	..	..	..	..	..
0·6	30	6	7	11	6	··	..	..	..	..	..
0·7	30	0	1	0	2	0	0	0	0	0	0
0·8	20	0	0	0	1	0	0	0	0	0	0
1·0	20	0	0	1	0	0	0	0	0	0	0
1·5	20	0	0	0	0	0	0	0	0	0	0
1·7–1·9	15	0	0	0	0	0	0	0	0	0	0

were capable of living in salinities between 0·7 and 1·9%. In freshwater they died within 24 hours while in salinities between 0·3 and 0·6% they survived for a maximum period of 3 to 4 days. The lethal salinity appears to lie between 0·6 and 0·7%. These results suggest that the oysters can be protected from the attack of *Pinnotheres* by exposing to a salinity of 0·6% or below for 4 to 5 days. However, this short period of exposure to low salinities do not kill the oyster themselves as they can survive up to 15 days in a salinity of 0·3%.[5]

Zoology Department,   R. NAGABHUSHANAM.
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A NEW *SCIRTOTHRIPS* ON COFFEE IN INDIA

THE terebrantian described herein appears to be a close congener of *Scirtothrips dobrowsky*, described by Moulton from tomato in the Philippine Islands [*The Philippine Journal of Agriculture*, 1936, 7 (2), 264]. It differs from *dobrowsky* consistently in bearing only one spine on the hind-vein instead of three, and in bearing two instead of three setæ along the anterior margin of the scale. These differences were determined by comparing the female holotype of *dobrowsky*, kindly lent me by the California Academy of Sciences, with two series of the new species collected on leaves of Arabica coffee by Dr. P. Soma Sekhar at the Central Coffee Research Institute, Chickmagalur District, Mysore State, the first collected during January–March 1963 and the second during March–April 1964.

I am informed by Dr. Soma Sekhar that the species injures leaves of coffee and is of some economic importance. At his request, I am naming the species after Dr. Harvey L. Sweetman of the University of Massachusetts.

Scirtothrips sweetmani SPEC. NOV.
(FIGS. A AND B)

Macropterous female : ·624 mm. long. General color grey ; all tarsi, first antennal segment, median third of abdominal segments 1–7, lighter ; most major setæ, antennal segments 2–8, narrow band on fore-margin of abdominal segments 318, conspicuously darker ; hind-tibiæ with two light bands but the base, the tip and the middle third grey. Eye pigment dark red. Ocellar pigment orange-red. Subhypodermal pigment yellow, almost lacking in some cases, abundant and dense in others, causing parts of the body to appear golden-yellow by transmitted light ; in one case similarly coloring the second antennal segment.

Head short and wide. Antennæ as illustrated, with colorless trichomes. Eyes occupying most of the head, noticeably setose, with about eight ommatidia in outline. Vertex declivous, with the middle ocellus anterior to a line across the middle of the eyes. Inter-ocellar setæ about as long as ocellar diameter, set between the posterior ocelli just ahead of a line tangent to both of them. Striation of conspicuous fine lines which converge upon the middle ocellus in front, form a few transverse reticuli on the inter-ocellar area, and are transversally subparallel on the cheeks and dorsum. Cheeks shorter than eye length, weakly convergent to base of mouth cone. Basal apodeme not darker than rest of
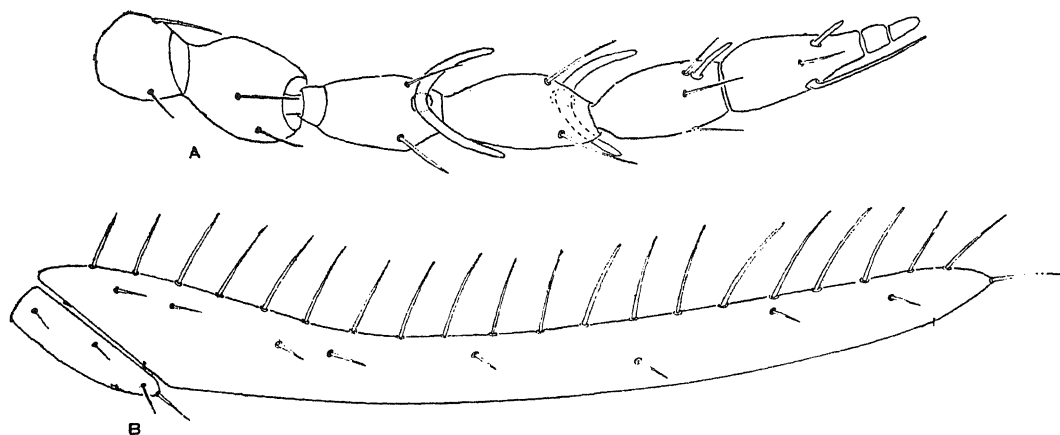
FIGS. A–B. Fig. A. Dorsal view of left antenna of female. Fig. B. Right forewing and scale of female.

head. Mouth cone broad, in normal expansion just reaching hind-margin of prosternum.

Pronotum ·065 mm. long, as wide as head in front and ·150 mm. wide on posterior margin ; with sides diverging in anterior half and parallel in posterior half ; bearing ten or twelve micro-setæ on the disk and a stout, pointed seta on the hind margin, half-way between the meson and the posterior angle. Pronotum and mesonotum densely striated with delicate, transverse, sub-parallel lines. In a lateral view of the prono-tum these striæ converge upon a slight inden-tation which marks the lateral apodeme. Metanotum with a pair of microsetæ far apart on the anterior margin and a similar pair closer together on the disk and removed by their own length from the margin ; with reticular striation which is clear on the disk but faint on the sides.

Wings with dense rows of microtrichia, with long, straight fringe hairs on both margins. Fore-wing with 18-20 weakly curved, stout spines on the fore-margin. The fore-vein marked by short, stout, dark spines arranged in 2-2-1-2 series. The hind-vein always with only one spine, just basad of the penultimate spine on the fore-vein. Hind-wing much lighter than fore-wing, with a conspicuously dark central band along its entire length. Scale long and narrow, with one dark spine on the disk near the base, two near the distal half of the anterior margin, and one at the end. Wing retaining setæ closely paired, long, thin, pale colored.

Legs hairy. Posterior tibiæ with a strong straight spine above the inner hind angle, and a much smaller spine at the angle itself.

Abdominal tergites 2-8 with a narrow dark band across the entire front margin. Tergites 1-7 smooth in the mesal third but with dense rows of microtrichia on the lateral thirds, the microtrichia extending into setiform combs dis-tad of the hind-margin. Tergite 8 with a regular comb along the entire margin ; with the lateral microtrichial areas joining in the front half of the tergite to leave only the mesal third of the distal half smooth. Tergites 2-8 with three microsetæ on the transverse midline of each microtrichial area, a smaller microseta on each side of the meson, and a relatively long, stout seta at each posterior angle. Tergite 9 with a pair of stout spines far apart on the transeverse midline and three on each side of the posterior margin ; the middle one of the latter colorless and much weaker than the other two. Tergite 10 with four terminal setæ, all stout but the inner pair darker than the outer pair. The ster-nites are pubescent on the lateral thirds, but the microtrichia are shorter than on the tergites and appear like stippling. Sternites 2-7 bear six relatively strong setæ on the posterior margin, none on the disk. Sternites 5-7 bear a dark arcuate band along the anterior margin.

Measurements of female holotype in microns.— Body length 624 ; length of head to tip of labrum 160 ; length of eye 50 ; width of head across eyes 135 ; length of pronotum 65 ; width of pronotum at posterior margin 150 ; width of metathorax in front 200 ; spine on posterior margin of prono-tum 45 ; posteroangular spines on 9th abdominal tergite 50 ; length of comb on 8th abdominal tergite 10 ; microsetæ on disk of metanotum 15.

Antennal segments :	1	2	3	4	5	6	7	8	Total
Length	20	25	35	32	36	35	5	10	198
Width	20	25	15	15	15	12	5	2	

Macropterous male.—592 microns when fully expanded; like the female in color, shape and pubescent areas; with abdominal segment 9 bearing six stout spines with prominent bases arranged in a semicircular line on the disk of the tergite, and a strong, dark inwardly curved drepanum on each side.

Described from the female holotype, the male allotype, one male and eighteen female paratypes collected during March and April 1964, and three female paratypes collected January to March 1963. This material is now in the author's collection and will eventually be deposited with the Bernice P. Bishop Museum, Honolulu, Hawaii.

Experiment Station,   F. A. BIANCHI.
Hawaiian Sugar Planters' Assn.,
Honolulu, Hawaii, U.S.A.,
November 12, 1964.

EPICOCCUM NIGRUM LINK ON STORED FRUITS OF *ZIZYPHUS JUJUBA* LAMK

DURING December 1962, a storage rot disease of *Zizyphus jujuba* (Vern. *Ber*) was observed in the local markets. The infected fruits had chocolate-grey to dull-black spots. Isolations from diseased areas gave a species of *Epicoccum*. Pathogenicity was tested both by injury and contact methods. Since the fungus has not been recorded on this host earlier a brief account of symptoms and morphology of the organism has been recorded here.

The disease starts as small light-brown spots with a water-soaked appearance. These spots gradually enlarge in size and their colour changes to dark brown. Some times spots coalesce to form bigger spots and they become chocolate-grey to dull black with black margin. These spots remain quite distinct from the healthy portion of the fruits. A section of the diseased fruit shows that the fungus causes a soft rot of the fleshy tissue.

The fungus grows well on Asthana and Hawker's Medium 'A' at 25° C. (± 2° C.). In culture the mycelial colony is brownish-yellow in colour. Sporodochia are scattered and hemispherical in shape. Conidiophores are club-shaped, brown in colour, $4 \cdot 5$–$7 \cdot 0 \times 12 \cdot 0$–$14 \cdot 3 \mu$ in size. Conidia are spherical, $20 \cdot 4$ to $25 \cdot 0 \mu$ wide, brown in colour, borne singly at the tip of conidiophores. Conidial surface is verruculose.

On the basis of the above morphological characters the organism is specified as *Epicoccum nigrum* Link and it has been confirmed by Commonwealth Mycological Institute, Kew, Surrey, England. This species of *Epicoccum* has earlier been recorded on maize (Ellis, 1956)[1] and *Ginkgo biloba* (Neely, 1959)[2] in U.S.A. Cross-inoculations were successful only on the fruits of *Prunus persica* Stokes and *Cucumis melo* L. while it failed to infect *Pyrus malus*, *Pyrus communis* L., *Trichosanthes dioica* Roxb. and *Cucumis sativus* L.

A culture has been deposited at the Commonwealth Mycological Institute, Kew, Surrey, England (C.M.I. No. 95017), and also at the Plant Pathological Laboratory of the Botany Department, Allahabad University.

Our grateful thanks are due to Dr. J. C. F. Hopkins of C.M.I., Kew, Surrey, England, for confirming the identity of the fungus.

Plant Pathological Laboratory,   SUDHIR CHANDRA.
Botany Department,   R. N. TANDON.
Allahabad University,
Allahabad, *July* 23, 1964.

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CHROMOSOME DIMINUTION IN THE ROOTS OF *ALOE VERA* L.

SOMATIC reduction has been recorded as an unusual feature in certain plant species. Ross and his school have reported on the colchicine-induced somatic reduction where a full genome gets eliminated in the somatic tissues of *Sorghum vulgare.*[1] Comparable phenomena have been recorded recently in the normal roots of *Allium.*[2] Instead of the full genome one or a few chromosomes may get eliminated from one or more tissues of the plant. Thus in *Xanthisma texanum,*[3] *Sorghum purpureo-sericeum,*[4] *Haplopappus gracilis,*[5] *H. spinulosa*[6] and *Crepis pannonica*[7] the accessory chromosomes are found in the germ line but not in the roots. Sampath[8] recorded chromosome diminution in the roots of *Oryza sativa* × *eichingeri*. A situation where some chromosomes of the regular complement get eliminated only in a part of the root system while other roots and the germ line possess the normal chromosome number has been observed in *Aloe vera* and is reported here.

While studying the chromosome complement of *Aloe* a few roots were observed to have $2n = 10$ instead of $2n = 14$, the normal diploid number. However, on further investigation a part of the same root system showed $2n = 14$ also. The entire root system was therefore divided into 8 sectors and 5 randomly selected root-tips were studied from each. It showed

sectors 2, 4, 6 and 8 to have $2n = 14$ and sectors 1 and 7 to have $2n = 10$ chromosomes. Sectors 3 and 5 were having $2n = 10$ in some roots and $2n = 14$ in others. However, the exact zone of transition could not be ascertained. Nor could it be decided whether this reduction of 4 chromosomes is a single step process.

The chromosome morphology of both the above types of cell populations was analysed to locate the types of chromosomes that get eliminated. The chromosome complement of the normal cell (Fig. 1) has 8 long chromosomes
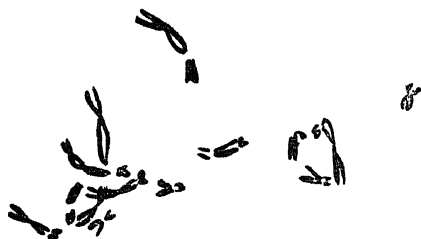
FIG. 1

FIG. 2.

FIG. 3.

FIGS. 1-3. Fig. 1. A normal ($2n = 14$) cell at metaphase ($\times$ 918). Fig. 2. A cell with $2n = 10$ at metaphase. Note the different (A and B) small chromosomes ($\times$ 1108). Fig. 3. A deficient cell with $2n = 10$ at anaphase ($\times$ 1101).

and 6 very small ones. Three pairs of these long chromosomes have subterminal centromeres and the fourth one has a terminal one. All these can be easily distinguished from the short pairs, purely by their length. Among the 3 short pairs the centromere is median in one of the pairs and sub-median in the others. Excepting the 6th and 7th which appear alike, the rest are easy to distinguish,

The cells with 10 chromosomes (Fig. 2) have 4 complete pairs of long chromosomes. The remaining two chromosomes are unequal in length. They vary also in the position of their kinetochores. The longer member (A of Fig. 2) has a sub-median centromere while in the other (B of Fig. 2) it is median. A drawing of such a deficient cell at late anaphase is presented as Fig. 3, to illustrate the chromosome number ($2n = 10$). It would appear that the dificient cells had lost one homologue of each of the chromosome pairs numbered 5, 6 and 7. The 4th chromosome missing may be the 2nd homologue of either of the pairs numbered 6 and 7.

I am thankful to Dr. A. Rathore and Prof. H. N. Mehrotra for facilities.

Rajasthan College of Agriculture,   B. K. VIG.
Udaipur, *August* 8, 1964.

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A NEW SPECIES OF *LACELLINOPSIS* FROM HYDERABAD

THE genus *Lacellinopsis* was proposed by Subramanian (1953) to accommodate a dematiaceous amerosporous fungus (*L. sacchari*) which differed from its nearest genus *Lacellina* Sacc., in producing conidiophores with apical fertile vesicles, cutting off acropleurogenous catenate conidia and conidiophores proliferating from the vesicular portion. Later two more species, *viz.*, *L. levispora* and *L. desmostachyæ* were described by Subramanian (1954), and Roy and Dwivedi (1961) respectively. In this communication an undescribed *Lacellinopsis* is reported, collected by the authors during their study on Hyphomycetes of Hyderabad.

Lacellinopsis Osmaniæ SP. NOV.

This fungus produces black, irregular effuse colonies on the substratum, extending up to 4-6 mm. long and 1-2 mm. broad. Creeping hyphæ scanty, subhyaline, branched, 2-4 μ broad, septate with septa up to 13·6 μ apart. Conidiophores arise from the creeping hyphæ

and are intermixed with sterile setæ. Setæ are erect, flexuous, dark brown at base becoming paler at the apices, thick-walled, smooth, 119–306 μ long, 3·4–7·8 μ broad at base and 2–4 μ broad in the apical region with obtuse or pointed ends, 3–8 septate with septa up to 40·8 μ apart. Conidiophores are light brown, flexuous or bent, rarely straight, smooth and thin-walled, simple or branched with apical fertile vesicles. Conidiophores 34–142 μ long, 2–5 μ broad, deep yellow at the base, becoming dark yellow at the vesicular region, 1–4 septate. The branching of the conidiophore is either from the vesicle during proliferation or from the main axis, branches one to two, up to 45 μ long, 0–2 septate. The vesicle is globular to oval, thick-walled, 6·8–10·8 μ in diameter. Proliferation of the conidiophore is effected by the invagination of the vesicle and repeated growth of the conidiophore from it. Three to four successive proliferations have been observed. Conidia oval to spherical, short warticulate, thick-walled, dark brown, catenate, acropetal, 7–11·2 μ in diameter, produced acropleurogenously from the vesicle. Conidia form simple or branched chains, up to 25 μ in length.

This fungus differs from all the species of *Lacellinopsis* so far known, in the branching of conidiophore, measurements of conidiophore, conidia and the sporoderm. Hence it is described as a new species *L. Osmaniæ,* named after the alma matar Osmania University, Hyderabad, A.P., India.

Collected on dead leaves of *Typha elephantina* Grah. from Osmania University campus on 1-9-1963. Coll. Satyanarayana, Herbarium hyderabandense V.V.C.B.L. No. 305.

Lacellinopsis Osmaniæ SP. NOV.

Coloniæ effusæ, carbonaceas, magnitudinæ varia 4–6 mm. longa, 1–2 mm. lata. Hyphæ repentes ramosæ, subhyalinæ, septatæ, 2–4 μ latæ, setæ et conidiophori dense aggregati. Setæ simplices, steriles, erectæ 119–306 μ longæ, 3·4–7·8 μ latæ ad basim 2–4 μ latæ ad apicem, fuscæ brunneæ ad basim ; progressive pallidiores evadentes ad apicem, 3–8 septatæ, septa usque 40·8 μ distantibus. Conidiophori simplices vel ramosi, recti vel flexousi 34–142 μ longi, 2–5 μ lati, 3–8 septati, pallidiores ad basim, fuscæ brunneæ ad apicem. Apice globosa, fertili ornati, 6·8–10·2 μ diam. Ramuli usque 45 μ longi. Conidia producta acrogena ex apice globoso conidiophorum, catenata, acropetala, ovalia vel spherica 7–11·2 μ diam., brunnea, warticulata, catena simplices vel ramosas usque 25 μ longas. Conidiophoris proliferentes per cupulatum

apicem atque, producentes conidia ulteriora.

Typus lectus in foliis emortius *Typhæ elephantinæ* Grah., in loco Hyderabad a Satyanarayana die 1 mensis septembris anni 1963 et positus in herbario hyderabadensi V.V.C.B.L. sub numero 305.
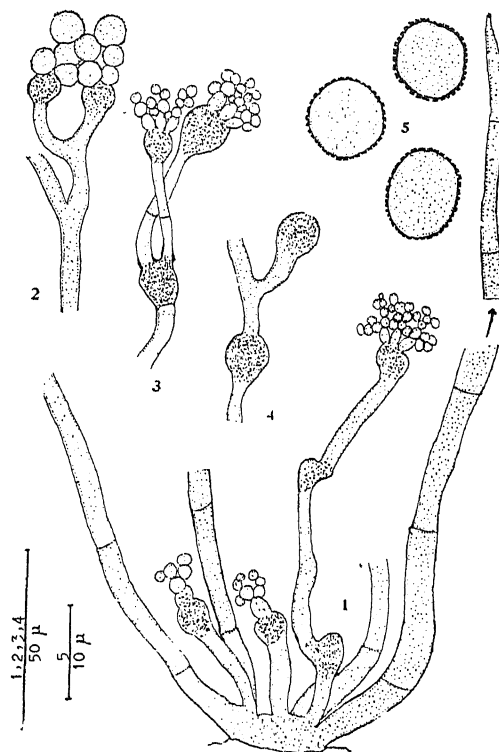
FIGS. 1–5. *Lacellinopsis Osmaniæ* (from type material V.V.C.BL. No. 305). Fig. 1. A colony with conidiophores and setæ. Fig. 2. Branched conidiophore. Fig. 3. Branching of conidiophore after poliferation. Fig. 4. Proliferated and branched conidiophore. Fig. 5. Conidia.

Department of Botany,   A. SATYANARAYANA.
A.U. College,
     and
Vivek Vardhini College,   DEV RAO.
Hyderabad, A.P., India,
November 13, 1964.

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ONION ROOT GIBBERELLINS

THE naturally-occurring gibberellins of seeds and leaves of higher plants have been well investigated while those of roots have relatively been little studied.[1-3] Therefore it is of interest to examine the native gibberellins of actively growing roots. The roots of onion plant, *Allium cepa* were selected for this investigation.

Onion plants were grown from bulbs in pans of sand under natural conditions in the garden. Twenty days after planting the roots were separated from the plants, washed, and were subjected to the extraction of gibberellins according to the method of Corcoran and Phinney.[4] The roots (about 20 g.) were ground in acetone : water (1 : 1), the macerate was left for 24 hours at 15° C. and was filtered. The filtrate was concentrated on a boiling water bath and was used for paper chromatographic analysis of gibberellins.

The sheets (Whatman No. 1) were run unidirectionally in an ascending technique in three different solvent systems (Table I). Dried papers were sprayed with the chromogenic reagent,[5] 0·5% aqueous potassium permanganate to detect gibberellin-like substances which appear as yellow spots on purple background.

The analysis showed that two compounds positive to permanganate reagent were present in the extract. The chromatographic behaviour of these substances is summarized in Table I.

TABLE I

Chromatographic characteristics of gibberellin-like substances in onion roots

	n-Butanol/ Acetic acid/ water 19 : 1 : 6	n-Butanol/ 1·5 N Ammonium hydroxide 3 : 1	Isopropanol/ 7 N Ammonium hydroxide 5 : 1
Substance 1 ..	0·86	0·22	0·58
Substance 2[1] ..	0·46	0·08	0·44

Substance 1 had identical behaviour in all the solvents tried in respect of Rf with the authentic sample of Gibberellic acid (gibberellin A_3). Additional confirmation was also obtained by spraying the sheet with 0·05% ferric chloride in 3·0% methanolic sulphuric acid.[6] Both the unknown and the authentic samples had no colour in visible light, but fluoresced blue green under U.V. light.

Bioassay of the above native gibberellic acid was done using rice seedling test.[7] The spot corresponding to A_3 was eluted with acetone : water (1 : 1) from the unsprayed sheet and eluate was evaporated to a small known volume and was tested for biological activity. The elongation of second leaf-sheath in rice seedlings of variety BCP I was measured and it was found that 6 g. of root material was equivalent to 1·0 μg. of authentic gibberellic acid in biological activity. Substance 2 is at the moment unidentified.

Thus the present investigation has revealed occurrence of gibberellin A_3 and an unidentified gibberellin in onion roots and it is highly probable that roots of other plants also contain similar native gibberellins. It is pointed out that gibberellic acid promotes synthesis of phenolic compounds which in turn control growth by way of increased auxin content.[8] Phenolic acids of onion roots have recently been studied by the present authors[9] and further work on the levels of native gibberellins and phenolic substances during different developmental stages will be most helpful in understanding the growth of roots.

The authors thank Prof. I. M. Rao for encouragement.

Department of Botany,   V. S. R. DAS.
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SOME OBSERVATIONS ON THE EMBRYOLOGY OF *HOLBOELLIA LATIFOLIA* WALL.

THE family Lardizabalaceæ is given an independent status by Engler and Prantl,[2] Hutchinson[3] and Rendle,[5] while Bentham and Hooker[1] treat it as a tribe of the Berberidaceæ. The earlier embryological findings on this family include those of Vesque[8] on *Holbœllia latifolia*, Vesler[7] on *Akebia quinata*, and Swamy[6] on *Decaisnea insignis*. The first two authors reported formation of parietal cells in the ovules. In addition, Vesler[7] made some observations on the pollen grains and embryo-sac. Swamy,[6] besides investigating pollen and embryo-sac, also traced the development of endosperm.

The material of *Holbœllia latifolia* was collected from the Lloyd Botanic Gardens,

Darjeeling, and Tonglu in the same district, during May-June 1962. The plant is a monœcious climbing shrub. The unisexual flowers are green or purplish-green and sweet-scented. There are 6 sepals arranged in two whorls, 6 minute orbicular petals, 6 free stamens, and 3 distinct carpels with oblong stigmas.

The anther wall consists of an epidermis, fibrous endothecium, two or three middle layers and a secretory tapetum. The tapetal cells contain 2 to 4 nuclei each which later fuse to form polyploid masses.

The reduction divisions in the microspore mother cells are simultaneous resulting in tetrahedral and decussate tetrads. The mature pollen grains are tricolpate and 2-celled at the time of shedding (Fig. 1).

In the female flowers the anthers degenerate. The contents may, however, develop up to the uninucleate pollen grain stage.

The ovary shows parietal placentation bearing numerous sub-sessile ovules, separated from each other by multicellular, uniseriate hairs developed from the inner epidermal cells of the carpel wall. These ovules are orthotropous, bitegmic and crassinucellate with well-developed parietal tissue formed also by periclinal divisions of the nucellar epidermis (Figs. 2, 3). The micropyle is organized by the inner integument alone.

Generally there is single (sometimes two) megaspore mother cell. It divides to form a dyad (Fig. 4), of which the upper dyad cell may sometimes remain undivided (Figs. 5, 6). When both the dyad cells divide (Fig. 7) mostly T-shaped tetrads of megaspores (Fig. 8), and rarely the linear ones, are produced. The chalazal megaspore functions and the development of the embryo-sac thus conforms to the Polygonum type (Maheshwari[4]).

The functional megaspore divides to form 2, 4, and 8-nucleate gametophytes (Figs. 9, 10). The micropylar quartet organizes earlier than the chalazal quartet. The mature embryo-sac consists of an egg apparatus, two polar nuclei and three antipodal cells (Fig. 10). The latter are ephemeral and degenerate even before fertilization.

The endosperm is cellular. The first division of the primary endosperm nucleus is transverse resulting in large micropylar and a small chalazal chamber (Fig. 11). Both the chambers contribute towards the endosperm formation, but divisions are more rapid in the chalazal region. This is also true of *Decaisnea*.[6]

A comparative study indicates that Lardizabalaceæ deserve the status of an indepednent family and need not be merged with the Berberidaceæ.

FIGS. 1-11. Fig. 1 Mature pollen grain. Fig. 2. Ovule. Fig. 3. Portion of ovule enlarged to show megaspore mother cell. Fig. 4. Dyad. Figs. 5-6. Lower dyad is dividing while the upper one is degenerating. Figs. 7-8. T-shaped tetrads of megaspores. Figs. 9-10. Two-nucleate and mature embryo embryo-sacs respectively. In Fig. 10. the polars have fused. Fig. 11. Fertilized embryo-sac showing two-celled endosperm and persistent synergid. (Fig. 2, × 100; Others, × 450).

I am grateful to Dr. Bahadur Singh for guidance and comments, and to Professor K. N. Kaul for encouragement and facilities.

Botany Laboratory,   S. P. Bhatnagar.
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REVIEWS

Introduction to Infra-Red and Raman Spectroscopy. By N. B. Colthup, L. H. Daly and S. E. Wiberley. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. xii + 511. Price $ 12.00.

This book is intended to fill a long-felt need for an elementary treatment of infra-red and Raman spectroscopy. It covers theory and instrumentation, and emphasizes group frequency correlations based on infra-red data. The subject is dealt with in fifteen chapters: I. Vibration and Rotational Spectra, II. Experimental Considerations, III. Classification of Molecules, IV. The Origin of Group Frequencies, V. Aliphatic Groups, VI. Triple Bonds and Cumulated Double Bonds, VII. Olefin Groups, VIII. Aromatic and Heteroaromatic Rings, IX. Carbonyl Compounds, X. Ethers, Alcohols, and Phenols, XI. Amines, C N and N O Compounds, XII. Compounds Containing Boron, Silicon, Phosphorus, Sulfur, or Halogen, XIII. Major Spectra-Structure Correlations by Spectral Regions, XIV. The Theoretical Analysis of Molecules and XV. The Calculation of Thermodynamic Functions.

The reviewer is very favourably impressed by the book. Though the authors make only the modest claim that the book has been written for the student, or the organic or analytical chemist who does not feel qualified to call himself a spectroscopist, actually it should have a much wider appeal.   C. V. R.

Synchytrium. By J. S. Karling. (Academic Press, Inc., New York and London), 1964. Pp. I to XVI and 1 to 470. Price $ 17.50.

Synchytrium is a genus of plant parasite. It is the largest and most commonly known chytrid genus which is reported to include almost 200 species and is world-wide in its distribution. It is of interest to note that the species *S. endobioticum* is responsible for the wart disease of potatoes, also known as black scab. Another species, *S. trichosanthidis* attacks the fruits and leaves of *Trichosanthis dioica*, a cucurbit of much importance as a vegetable in India. *S. sesamicola* causes a serious disease of *Sesamum indicum*.

Dr. Karling's monograph presents all data and information relevant to the identification, classification, and phylogeny of species of this interesting genus. It contains full-plate illustrations of the life-cycles of each subgenous, drawings of nuclear and cell division, gall development and variation, and of cellular reactions to infection, as also diagrams illustrating various concepts of sexuality in the genus. A whole chapter deals with the geographical distribution. Another contains a host index. Extensive references and a complete bibliography of wart disease in potatoes also appear.

Mycologists, botanists and biologists should find the book useful. Likewise, it should especially appeal to parasitologists and phytopathologists.   C. V. R.

Lipid Pharmacology (Volume 2 of Medicinal Chemistry). Edited by Rodolf Paoletti. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xiii + 538. Price $ 17.50.

The Institute of Pharmacology and Therapeutics at the University of Milan in the year 1960 organised a symposium of which the principal theme was the effect of drugs on lipid metabolism. This symposium greatly stimulated the interest of pharmacologists in this subject. One of the recent developments in the field has been the realisation that lipid metabolism is perhaps more sensitive than carbohydrate metabolism to environmental changes and to drug influences.

Dr. Paoletti of the University of Milan has brought together in the volume under review a series of summaries and reviews which reflect the current state of lipid pharmacology. Chapter 1 by Marjorie G. Horning deals with Methods for the Study of Lipid Changes in Biological Experiments; Chapter 2 by David Kritchevsky deals with Experimental Atherosclerosis; Chapter 3 by William L. Holmes deals with Drugs Affecting Lipid Synthesis; Chapter 4 by M. W. Whitehouse deals with Drugs, Hormones, and Other Factors Influencing Steroid and Sterol Metabolism; Chapter 5 by H. M. Sinclair deals with Essential Fatty Acids; Chapter 6 by O. Neal Miller and James G. Hamilton deals with Nicotinic Acid and Derivatives; Chapter 7 by N. B. Myant deals with The Thyroid and Lipid Metabolism; Chapter 8 by Norman B. Marshall deals with Gonadal Hormones and Lipid Metabolism; Chapter 9 by Richard J. Havel deals with Catecholamines; Chapter 10 by Georg E.

Cronheim deals with Heparin, Heparinoids, and the Clearing Factor; Chapter 11 by P. Preziosi deals with Drugs Acting on Lipid Catabolism and Excretion; Chapter 12 by Robert L. Smith deals with The Metabolism and Disposition of Hypocholesteremic Drugs.

The publication of this volume will undoubtly render great service to the subject of lipid pharmacology and stimulate the pharmacologists to realise that many unsolved problems in the lipid field are amenable to study by combined biochemical and pharmacological techniques, and that the effects of drugs on lipid metabolism are deserving of more intensive study than has been the case in the past.

C. V. R.

Elasticity, Plasticity and Structure of Matter. By R. Houwink. (Dover Publications, Inc., New York). Pp. I to XVIII and 1 to 368. Price two dollars and forty-five cents.

Photoelasticity : Principles and Methods. By H. T. Jessop and F. C. Harris. (Dover Publications, Inc., New York). Pp. 1 to 184. Price two dollars.

The Dover edition of the first book is an unabridged republication of the second edition of the original book issued in 1952 by the Cambridge University Press. The book covers a wide field, *viz.*, crystals, amorphous substances such as glass, resins, asphalt, rubber and rubber-like substances, cellulose and its derivatives, proteins, baker's dough, paints and lacquers, clay and sulphur. By reason of this wide coverage and the immense practical importance of the field of knowledge, the book is of interest and this republication is to be welcomed.

The second book is an unabridged and unaltered republication of the book which was originally issued by the Cleaver-Hume Press in 1949. The book was written for the engineer or designer who wishes to have a primarily physical and practical survey of photoelasticity. This purpose is kept in view throughout. The book should be very helpful to those for whom it is intended.   C. V. R.

Gas Chromatography. Edited by Lewis Fowler. (Academic Press, Inc., New York and London), 1963. Pp. xiv + 270. Price $ 10.50.

The book presents edited proceedings of the Fourth International Symposium on Gas Chromatography conducted by Instrument Society of America, during June 1963. The question that comes to one's mind is : Is there so much to discuss even now about Gas Chromatography

(G.C.) especially after more than half a dozen authoritative monographs have appeared on it, and already it has become a well-accepted tool. This question is answered by the book simply and directly. The potentialities of this technique are by no means exhausted (in spite of the present rate of over 1,800 publications a year).

The opening address on "Trends in Gas Chromatography" by Dr. S. D. Nogare, a respected expert in the field, forms the first chapter (of a total of sixteen). Nine of the chapters deal with specialized applications and appropriate design modifications. They include developments in column technology, role of back flushing, application of group type analysis, application of G.C. in petroleum industry, analysis of xylene oxidation mixture and design of a valve for high-speed G.C. There is a chapter on detector theory and applications, and one on characteristics of catalytic combustion ionization detectors. The chapter on collecting fractions for infra-red analysis will be particularly useful to a large number of research workers in varied fields. Reduced pressure G.C., theory of packed column efficiency, and thermodynamics of solutions have been covered in separate chapters. Discussion is included at the end of every chapter.

An impressive demonstration of the capability of G.C. is provided in a chapter in which are discussed ortho-para hydrogen separation and analysis of trace impurities (parts per billion range) in cryogenic samples of hydrogen.

There is no escaping the all-pervasive influence of the Moon even by G.C. One of the chapters outlines the design problems (and their solution) involved in the construction of a Lunar Gas Chromatograph proposed to be sent in the "Surveyor" to the moon.

This book makes a valuable and important contribution to the literature of G.C. There is a rich and varied fare for the serious student as well as for the merely curious. The book is warmly recommended to the former and to all scientific libraries.   M. V. BHATT.

Microbiological Quality of Foods (*Proceedings of a Conference : Franconia, New Hampshire, August, 1962*). Edited by L. W. Slanetz, C. O. Chichester, A. R. Gaufin and Z. J. Ordal. (Academic Press, Inc., New York and London), 1963. Pp. xxiii + 274. Price $ 9.00.

The pace of progress in methods of food preservation, processing and packaging has been rapid and it is questionable whether problems

of potential public health significance have kept abreast of technological developments in the industry. The present publication serves the useful and needed purpose of reviewing problem areas covering food-borne diseases, indices of quality standards for foods and, above all, research needs.

The various topics presented and discussed by food microbiologists representing universities, research institutions, government agencies and industry serve to emphasize the breadth and complexity of the problem as a whole and, especially, the gaps in scientific information that can only be closed by additional research. This is so even with respect to the seemingly stabilised and problem-free technology of canning, not to speak of the spoilage problems of fresh, refrigerated, frozen and dehydrated foods. The use, increasingly, of unconventional wrappers which do not ensure sterility also introduces new problems calling for careful study.

It is refreshing to find in the various papers presented many leads to fundamental studies with potential practical applications. A few examples may be cited : J. H. B. Christian has attempted to correlate microbial growth in dehydrated foods with moisture activity expressed as a ratio of water vapour pressure of the food to that of water at the same temperature ; such a study may enable to set forth moisture limits to prevent the growth of molds, yeasts and bacteria. Again, softening, a major deteriorative change in fresh, refrigerated fruits and vegetables, is shown by R. H. Vaughn to be caused primarily by certain organisms elaborating pectolytic enzymes which, contrary to accepted views, attack the pectin molecules in a random manner ; a better understanding of the fundamentals of this enzyme will be of help in arresting this kind of spoilage. M. Ingram has referred to the fact that organisms causing spoilage do so largely because of the alterations in certain selective substrates in foods ; hence, there is need to ascertain more systematically their metabolic activities.

The Proceedings of this Conference on Microbiology of foods are of especial significance when one realises that (*a*) there has lately been an increase in outbreaks of salmonellosis and other food-borne infections in various areas of the world, (*b*) food-poisoning episodes are likely to be vastly more than those that come for detection, investigation and reporting, and (*c*) newer developments in food processing and packaging methods may involve unanticipated hazards. The book, though failing to touch

upon a number of new areas such as microbiology of irradiated and minimally processed foods, offers full-spectrum thinking in terms of co-ordinated programmes between research, industry and government to improve technical intelligence, laboratory methods, evaluative criteria and operational procedures for the protection of public health.   A. S.

Rothamsted Experimental Station—Report for 1963. (From the Librarian, RES, Harpenden, Herts, England), 1964. Pp. 318. Price 15 *sh.* post free.

The Annual Report for 1963 of the Rothamsted Experimental Station contains the general report of the Director Mr. F. C. Bawden, F.R.S., and the individual reports of the progress of work during the year from the thirteen departments of the Station.

The farm reports relating to fertilizer practice emphasise the importance of the use of fertilizers more discriminately and less routinely. For example, it has been pointed out, from results of experimental studies, that giving nitrogen when it produces no response is simply waste ; on the other hand, even if more of phosphate and potash than is needed for the crop is given, the excess is retained in the soil and will provide food for future crops "perhaps more than 50 years later".

The Insecticides and Fungicides Department has been continuing the work on pyrethrins and related compounds, and new approaches of study have been initiated during the year. These include the study of nuclear magnetic resonance (NMR) spectra of these molecules. The NMR technique gives precise information on the stereochemistry and even the preferred conformation of molecules, and this information is of special value for biologically active compounds such as the pyrethrins, whose toxicity is known to be intimately connected with the structure and shape of the molecules. The results may lead to evolving synthetic substitutes which may be more stable and less expensive than natural pyrethrins.

It has been pointed out that organo-phosphorous compounds have proved in some cases especially control of wireworms, to be more effective in control of soil pests, than chlorinated hydrocarbons which are being used now.

There are two special reviews of interest. One is on "Mobilisation Phenomena in Soils" with special reference to the mobilisation of iron in the soil, particularly in relation to the processes of gley and podzol formation. The second

review is on the "Parp Grass Experiment" which, among other things, notes the changes in botanical composition of the herbage caused by continued manuring with fertilizers and dressings of lime.

The Report also contains abstracts of more than 250 papers published during the year from the various departments of the Station.

A. S. G.

Radiation Radioactivity and Insects. By R. D. O'Brien and L. S. Wolfe. (Academic Press, Inc., New York-3), 1964. Pp. xv + 211. Price : Cloth bound $ 5.95, Paper $ 3.45.

"Those strange and mystical changes," observed Sir Thomas Browne, referring to insects and their metamorphosis, "that I have observed in silkworms turned my Philosophy into Divinity, for there is in these works of Nature which seem to puzzle reason, something Divine, and hath more in it than the eye of a common spectator doth discover." And it is this 'puzzling' topic that is the subject of this monograph.

The book opens with an introductory chapter on insects and their structural, functional and behavioral features. It details their importance in the animal kingdom, their classification, anatomy, embryology, physiology, biochemistry and their advantages as experimental animals for various metabolic and other studies. The subsequent five chapters mainly discuss the utilization of radiation and radioisotopes in the study of insects for labelling purposes and for the elucidation of the mechanisms of complex biochemical reactions involved in their physiological and toxicological studies. The discussion includes the effects of radiation on insects under diverse conditions, tagging technique, radio-sterilization for pest control, the radioisotopic studies of protein biosynthesis and the different metabolic pathways of carbohydrates, lipids, and amino-acids. The chapter on 'Insects and Light' deserves special mention. It describes the recent work on rhabdomere, the site of the visual photochemical reaction, the response of insects to light and the origin of diurnal rhythms. The book concludes with three chapters on insecticide metabolism—a favourite topic of investigation among the modern entomologists and biochemists.

The monograph is concise and well-proportioned and provides well-knit knowledge of the subject to the students and workers in the field.

RADHA PANT.

The Soybean : Genetics, Breeding, Physiology, Nutrition and Management. Edited by A. G. Norman. (Academic Press, Inc., New York), 1963. Pp. x + 239. Price $ 6.00.

Knowledge on the Soybean, which has the nitrogen nutrition of a legume with uses more diverse than most grains, has received a varied approach in this volume in which progress in this rapidly expanding field of research is reviewed and summarized in four sections.

It is several years since a legume has been treated in this way and this book represents a daring and welcome review of updated articles originally published in *Advances in Agronomy.* Although the emphasis is on research in the basic and applied sciences relating to the soybean crop, features of crop growth ranging from the biochemical to the edaphic levels are critically discussed with experimental findings on which they are based.

A general survey by Johnson and Bernard emphasizes the desirability of increasing genetic diversity and of evaluating the breeding potential of soybean selections of diverse origin in the germ plasm. It indicates the importance of research in this field in legumes where the breeding objectives are notably resistant to disease and selection of suitable ecotypes or strains. Howell reviews the physiology of soybean with several stimulating problems on its productivity, nitrogen fixation and differences in physiological attributes limiting productivity—problems to which only partial answers exist to some, with complete answers probably to none. Ohrlogg describes recent work on the mineral nutrition of soybeans and discusses the need for an application of spectrographic, X-ray fluorescence or neutron activation analytical methods, multiple regression and electronic computers in nutritional studies to define nutrient interactions or what concentrations in plant parts best define nutritional levels. He suggests the need to combine breeding objectives with an analysis of mineral nutrition problems to assess the physiological basis for varietal improvement. However, the growth analysis studies which the author points out to have been so numerous in the United Kingdom, could have profitably been integrated with a study of dry matter accumulation and nutrient element intake in the manner prescribed by Goodall and Gregory (Commonwealth Agricultural Bureau) for oats and other cereals in the classical method of Mitschelich. Finally, the volume closes with Carter and Hartwig's excellent and succinct account of the soybean built around aspects of

its nodulation, nitrogen metabolism, balanced nutrient supply and farm management practices.

This volume on a crop which takes the first place in the oilseed crops of the Western hemisphere, is well produced and makes valuable reading for those wishing to be informed of the application of the Sciences of plant breeding, plant pathology, plant physiology, soil management, engineering and economics of the growing of Soybeans.　　　　T. S. SADASIVAN.

Books Received

Handbook of Dairy Science. By K. C. Mahanta. (Kitabistan, Allahabad), 1964. Pp. iv + 518. Price Rs. 20·00.

The Concept of a Riemann Surface. By H. Weyl. (Addison-Wesley Pub., Reading, Mass.), 1964. Pp. x + 191. Price $ 12.50.

A Dictionary of Science (Revised Edition). By E. B. Uvarov, D. R. Chapman and A. Isaacs. (Penguin Books Ltd., Middlesex, England), 1964. Pp. 336. Price 5 *sh.*

Handbook of Manures and Fertilizers. (Indian Council of Agriculture Research, Krishi Bhavan, New Delhi), 1964. Pp. 333. Price Rs. 6·50.

Computer-Oriented Mathematics—An Introduction to Numerical Methods. By L. D. Kovach. (Holden-Day, Inc., Sanfrancisco), 1964. Pp. vii + 98. Price : Cloth $ 3.95 ; Paper $ 2.95.

Advances in Experimental Social Psychology (Vol. 1). (Academic Press, Inc., 111, Fifth Avenue, New York 10003), 1964. Pp. xi + 319. Price $ 9.00.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Sri. V. A. Narasimha Murty for his thesis entitled "Studies on the Elastic Scattering of Gamma-Rays"; D.Sc. Degree in Geo-physics to Sri. P. Sitapati Rao for his thesis entitled "Magnetic Surveys in Parts of Godavari Valley and Magnetic Properties of Rocks".

Osmania University has awarded the Ph.D Degree in Physics to Sri. Vijay Kumar for his thesis entitled "Spectroscopic Studies on Molecular Associations"; Ph.D. Degree in Botany to (Miss) Nusrathunnisa for her thesis entitled "Studies on Seasonal Variation and Behaviour of Coprophilous Fungi from the Dungs of Certain Herbivores and Their Cellulolytic Activity with Special Reference to Curvularia Geniculate Chætomium Hyderabadense".

European Federation of Chemical Engineering

The 2nd European Symposium "Food—Recent Developments in Heat Treatment" will be organized from 31st March to 2nd April 1965 in Frankfurt (Main) by the Working Party on Food of the European Federation of Chemical Engineering and the Gesellschaft Deutscher Chemiker. At the same time this Symposium will be the 58th event of the European Federation of Chemical Engineering. The lectures of this Symposium will be divided into two groups —Group A : Physical and Technical Points of View of Heat Transfer ; Group B : The Influence of Heat on Food,

Further details on the Symposinm as well as the programme can be obtained at the following address : Gesellschaft Deutscher Chemiker, Dr. rer.nat. Wolfgang Fritsche, 6000 Frankfurt (Main), Postfach 9075, Varrentrappstr. 40-42.

Raptakos Medical Research Board Fellowships

The Raptakos Medical Research Board Fellowships for the year 1965 have been awarded to the following candidates for research work on subjects mentioned against their respective names : Senior Fellowship : (1) Sri. A. S. Balasubramanian, Christian Medical College and Hospital, Vellore—Biosynthesis and Metabolism of Mucopolysaccharides; (2) Sri. K. P. Gopinathan, Indian Institute of Science, Bangalore —Metabolism of Nicotinamide-Adenine Nucleotides of Myobacterium Tuberculosis. Junior Fellowship : (1) Mr. S. A. Bangalore, Indian Cancer Research Centre, Parel, Bombay-12— Immunological Studies with Rabbit Semen and Effect of Immunisation of Fertility ; (2) Dr. Amar Kishore Sharma, All-India Institute of Medical Sciences, New Delhi—Studies on the Changes in Serum Glutamic Exalacetic Transaminase and Serum Glutamic Pyruvic Transaminase in Some Dermatoses with Particular Reference to Leprosy and Collagen Diseases.

Dimethylsilene

Evidence for the existence of dimethylsilene, silicon analogue of carbene, has been provided independently by the chemists working at Pennsylvania State University, USA, and at the

Institute of Organic Chemistry, Academy of Sciences, USSR.

Chemists at the Pennsylvania University observed that when the reaction of dimethyl-dichlorosilane with Na/K vapour is carried out in a helium atmosphere a large portion of the product is left in the reaction zone as solid, probably polymeric. However, if a tenfold molar excess of trimethylsilane, $(CH_3)_3SiH$, is added to the helium stream pentamethyldisilane is produced. No satisfactory explanation can be advanced for the formation of pentamethyl-disilane in this gas-phase system, other than through the dimethylsilene intermediate reaction.

The Soviet chemists' proposal for the existence of dimethylsilene is also based on the kind of products produced when dimethyl-dichlorosilane is treated at 0–10° C. with lithium in tetrahydro-furan and ethylene to give 1, 1-dimethyl-1-silacyclopentane and 1, 1, 4, 4-tetramethyl-1, 4-disilacyclohexane. Some solid and liquid high molecular weight compounds are also formed in the reaction. Formation of silicon-containing heterocycles, tolomers and polymers can be explained only by assuming a transient dimethyl-silene intermediate.—[*Chem. Engg. News*, 1964, 42 (14), 40.]

A Three-Crystal X-Ray Spectrometer

The need for an exact knowledge of the X-ray diffraction patterns of crystal lattices and of their influence on the appearance of the emission and absorption spectra is well known. The dependence of diffraction patterns on the crystal lattices has been studied theoretically from the view-point of the dynamical theory for perfect, absorbing crystals. It has not yet been possible to compare the theoretical results directly with experimental investigations, since there has been no experimental possibility of producing a parallel and monochromatic beam of X-rays. An indirect verification of the correctness of the theory has been achieved through diffraction investigations with double crystal spectrometer, whereby comparisons between calculated and experimental rocking curves have been made. The study of the primary diffraction pattern directly to a high degree of accuracy has been made possible by a three-crystal X-ray spectro-meter.

The fast development of detection devices for X-rays, such as scintillation counters followed by pulse height analyzers has enabled modifications to be made in the double crystal spectro-meter whereby a good approximation of parallel and monochromatic X-rays may be obtained. In spectral investigations the double crystal spectrometer works with the crystals in the antiparallel position, whereby only one wave-length can be reflected from the second crystal. If this monochromator crystal of the double crystal spectrometer is replaced by a pair of crystals in the antiparallel position, a three crystal spectrometer is obtained.

The three-crystal spectrometer for X-ray investigations of primary diffraction patterns that has been constructed at the Department of Physics II, Chalmers University of Technology, is described in their Transactions Number 291, 1964. Its mechanical build-up, adjustment and use have been described with a number of illustrations. It has proved an extremely accurate instrument, and some preliminary results from measurements of diffraction patterns, total reflection and the curvature of lattice planes are presented.—(*Trans. Chalm. Univ. Tech.*, Gothemberg, Sweden, No. 291, 1964.)

Solar Origin of the Interplanetary Magnetic Field

Direct measurement of the interplanetary magnetic field has recently been made by an experiment conducted on the Interplanetary Monitoring Platform (IMP-1). The 63-kg. spin-stabilized satellite was launched on 17 November 1963 into a highly eccentric orbit with a geocentric apogee of 197,616 km. (radius of earth 6,368 km.), and an orbital period of 93·5 hrs. The sun-earth-apogee angle was initially 25° west of the sun and increased approximately 1°/day due to the earth's heliocentric motion. Successful transmission of scientific data continued for 180 days until 30 May 1964 when the sun-earth-apogee angle had increased to 201°. The interplanetary data are based on the average magnetic field computed every 5·46 minutes using 12 successive data transmissions at 20·5-second intervals.

Initial results of a detailed comparison of these interplanetary magnetic measurements with solar magnetograph observations of the photo-spheric magnetic fields as measured at the Mt. Wilson Observatory, have been reported in a recent communication to *Physical Review Letters* of 12 October 1964.

It is to be mentioned that the interaction of the solar wind (a continual flow of plasma from the photosphere of the sun) with the geomag-netic field disturbs the interplanetary medium in the immediate vicinity of the earth and spatially confines the Earth's field. Thus the

IMP-1 measurements used in the comparison are those restricted to times centred about the satellites apogee when it lay outside the interaction region which is limited to 85,000 km. at the subsolar point. These observations were limited to those obtained between 27 November 1963 and 17 February 1964, extending over three solar rotations, during which period the apogee was well above the region of disturbance.

The preliminary results reported are consistent with the general model of an interplanetary magnetic field of solar origin in which the effects of radial solar wind velocity and the solar rotation combine to produce the magnetic lines of force which are twisted in the plane of the ecliptic in the form of an Archimedes spiral. The latitude of the photospheric source is within 10 or 15° of the centre of the visible disk (or of the equator).—(*Phys. Rev. Letters*, 12 October 1964.)

Infra-Red Investigation of the Olivine Group Minerals

The olivine group minerals have the general formula M_2SiO_4, where M is a divalent cation such as Ca, Mg, Fe, Mn or a mixture of such cations. The olivine structure may be described as tetrahedral SiO_4 groups bonded together by divalent cations.

Results of a systematic investigation with the object of correlating the compositions of the olivine group minerals with variations in their infra-red absorption spectra, have been reported in a communication by D. A. Duke and J. D. Stephens to the *American Mineralogist* (1964, **49**, 1388). Thirty-seven olivine samples were investigated including twenty-two natural and fifteen synthetic specimans. Infra-red absorption spectra were obtained in the frequency range 4000 cm.$^{-1}$ to 400 cm.$^{-1}$

Seven absorption bands were noted in the spectra of all of the samples, characterizing the group. Configurations of the spectra were similar, but minor variations distinguished each system. Within any one substitution system the frequency of each absorption band varied systematically with the ratio of the substituent cations. These variations have been correlated with differences in the mass and ionic radii of the substituent cations; the frequencies of the absorption bands decrease as the mass and ionic radii increase.—(*Jour. Min. Soc. Amer.*, 1964, 49, 1388.)

Odour Research and Technology

Compared to the two other distance senses vision and hearing, smell has always attracted less scientific interest. Not only is this so because smell plays a very small part in man's civilized environment, but the approach to a scientific study of smell is itself beset with basic difficulties. However, during the last three or four decades the increasing recognition that the sense-organs are comparable, in terms of electronic circuitry, to the input sensors of a computer which, in a way, can be likened to the brain, and the advances in methods of anatomical and physiological investigations with micromanipulators, electron microscopes and a host of electronic devices, which has led to the technique of electrophysiology, have accelerated interest in researches connected with the organ of smell and the theory of odour. Still the workers in this field and organizations connected with it seem to be satisfied with a Decennial Conference only for discussing their progress.

The Annals of the New York Academy of Sciences, Vol. 116, Art. 2, Pages 357–746, is a Monograph on Recent Advances in Odor: Theory, Measurement, and Control. The 35 selected papers published in this monograph were presented at the Decennial Conference held by the Academy on November 7, 8 and 9, 1963. The papers are divided into five groups: (1) Odor Theory, Physiology and Chemistry, (2) Odor Correlation and the Panel Technique, (3) Odor Measurement, (4) Odor Control and (5) Fragrances and Cosmetics.

Each section is prefaced by a review of the concerned topic up to the last Decennial Conference of 1953, and the papers in each section indicate the progress that has been achieved during the decade.

(Enquiries concerning publications should be addressed to Executive Director, The New York Academy of Science, 2, East Sixty-Third Street, New York-21, N.Y.)

THE NEW PHYSIOLOGY OF VISION

Chapter IX.   The Structure of the Fovea

Sir C. V. RAMAN

THE preceding chapter commenced with an account of the author's studies of the phenomenon known as Haidinger's brushes seen when the polarised light of the sky is viewed by an observer. Investigations of the same phenomenon under controlled conditions and especially the studies in which monochromatic light was made use of showed clearly that these brushes have a physiological origin and represent a visual perception of the polarisation of light which takes its place along with the perception of form and the perception of colour as one of the special faculties associated with human vision. In the present chapter we shall concern ourself with the nature of the physiological mechanism which makes the perception of polarisation possible.

It is a remarkable circumstance that though the Haidinger phenomenon has been known for over a century, its importance in relation to the physiology of vision remained unrecognised. Largely, this was due to the general acceptance of an explanation of the phenomenon suggested long ago by Helmholtz, viz., that it is an effect arising from the dichroism of material contained in the macular region of the retina. This explanation, if correct, would make the brushes a physical curiosity having no physiological significance. It is therefore appropriate here to point out that the explanation given by Helmholtz is wholly untenable. This becomes evident when we examine the assumptions on which that explanation is based and also when we compare its consequences with the actual facts of the case.

As already stressed in the preceding chapter, special techniques are necessary for the visual perception of polarised light to manifest itself in an impressive fashion. One of the essentials is the use of a colour filter which cuts out all light having a wavelength greater than 500 mμ and transmits freely the region of the spectrum having shorter wave lengths. The luminosity of the field as seen through such a filter combined with a polaroid should also be adequate. When these requirements are satisfied, the field exhibits a bright brush running parallel to the direction of vibration of the light and a dark brush transverse to the direction of vibration. Employing the proper technique, we observe that the brush running transverse to the direction of vibration is completely dark.

If the facts of observation indicated above are to be explained on the assumption that the material of the retina in its foveal region has a radially symmetric structure which exhibits dichroism, it would be necessary for the absorption of light by the material to be effective and indeed total for optical vibrations along directions transverse to the radii of the structure and over the entire wavelength range between 400 mμ and 500 mμ. Further, there should be no absorption at all for directions parallel to the radii of the structure. These assumptions are inadmissible for the following reasons. In the first place, the retina being a thin membrane and especially thin in the region of the fovea, the presence in it of sufficient absorbing material completely to block out the entire spectrum between 400 mμ and 500 mμ is scarcely possible. Indeed, our eyes would then be unable to perceive the blue light of the spectrum. Another cogent objection is the known behaviour of fibrous materials dyed with organic dye-stuffs. In numerous cases where the dye-stuffs have elongated molecules, the dyed fibres do indeed display marked dichroism. But in all such cases, the strong absorption is manifested for directions of vibration *parallel* to the length of the fibres and not for directions *transverse* to them.

That an explanation of the brushes as a phenomenon of a purely physical origin is inadmissible becomes even clearer when we recall the observed features which indicate its physiological origin. The diminishing visibility of the brushes when the illumination of the field falls off and their disappearance at low levels of brightness puts the phenomenon in the same category as other aspects of our visual faculties. Striking evidence for their physiological nature is also forthcoming from the fact that an earlier exposure of the eye to polarised light has a great effect on their visibility. Indeed, such exposure can even result in the brushes being seen reversed when the polaroid is removed and the light incident on the eye is unpolarised. To exhibit this effect, the observer should hold the colour filter and polaroid before his eye and view a field which is adequately luminous for a sufficient interval of time to allow the

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brushes seen at first completely to fade away. He should then suddenly remove the polaroid, but allow the colour filter to remain in place. *He will then see the brushes once again but turned through a right angle.* In other words, the fovea then perceives with enhanced bright-ness that part of the incident unpolarised light which was cut off by the polaroid when it was in place before the observer's eye.

The Carotenoid Pigments.—That the power to recognise polarised light and to locate its plane of polarisation is exhibited by the foveal region of the retina and that it is limited to the blue-violet sector of the spectrum indicates that the brushes arise as a consequence of some special features in the distribution within the fovea of the material which enables us to perceive light in that part of the spectrum. We have, therefore, firstly, to identify the nature of that material and secondly, to find how it is distributed within the fovea.

One of the very striking features of the visible spectrum is the rapidity of the transi-tion from the blue into the green region. The transition takes place within a range of some 20 mμ and is centred around the wavelength 500 mμ. We may infer from this that the material which activates the perception of light in the blue-violet sector of the spectrum has an absorption which falls steeply from a large value to nearly zero at 500 mμ. The absorptive power should also be large in the spectral region between 400 mμ and 500 mμ and should drop down to low values for wavelengths less than 400 mμ. Two pigments which are known to exhibit these features in absorption are β-carotene and dihydroxy-α-carotene. They are plant pigments almost universally present in the green leaves of plants. They find their way into the human body as the result of the con-sumption of various food products and are present as colouring matters in the serum of human blood. β-carotene and dihydroxy-α-carotene differ distinguishably in their spectro-scopic behaviour. The former is optically inactive, being symmetric in its structure. The latter substance—which we shall hereafter refer to as xanthophyll—exhibits optical activity as its structure is asymmetric. The two substances also differ by reason of β-carotene being a precursor of vitamin A, whereas xanthophyll is not.

Both β-carotene and xanthophyll have been reported as having been found in the human retina. We shall not here pause to discuss which of the two should be identified as the pigment present in the retina enabling us to perceive bright light in the blue-violet range of the spectrum. It is not necessary to discuss that issue here, since they both have elongated molecules and possess the optical behaviour which could provide an explanation for the perception of polarised light.

The Distribution of the Pigments in the Fovea.—The fovea is a circular depression in the retinal membrane having a diameter of about one millimetre. Its structure exhibits some very special anatomical features. It is densely packed with a mosaic of the visual receptors known as cones. In this region these cones are much elongated and have a much smaller cross-section than elsewhere. The smaller thickness of the retina in the foveal region is the result of several nervous layers present in other parts of the retina being either absent or greatly reduced in thickness in the foveal depression. In this region, also, the nerve fibres connected with the cones are pushed to one side and run an oblique course, except at the very centre of the foveal depression where they form a criss-cross pattern. Thus, if we exclude this central region, the fovea elsewhere exhibits a radially symmetric structure by reason of the disposition of the nerve fibres leading away from the mosaic of cones which fills the pit in the retina.

The carotenoid pigments have highly elongated molecules. β-carotene and xanthophyll have respectively the chemical formulae $C_{40}H_{56}$ and $C_{40}H_{56}O_2$. Apart from the two end groups which are different in the two cases each molecule in these compounds consists of a long chain of carbon atoms held together by an alternation of double and single bonds of which there are eleven pairs. It is this structure that enables the molecule to exhibit an absorption stretching far into the visible region of the spectrum—from its violet end up to and inclusive of the blue sector. The geometry of the structure would necessarily lead to this absorption having selec-tive directional properties, being confined to directions of vibration parallel to the long chain and absent for vibrations in directions trans-verse to that chain.

Highly elongated molecules such as those of β-carotene and xanthophyll finding themselves in an environment of nerve fibres disposed with radial symmetry in the regions of the foveal depression around its centre may be expected to align themselves parallel to the nerve fibres and hence also to exhibit a radial symmetry in their disposition. Jointly as a result of such

disposition and the optical characters indicated above, it would follow that the absorption of the light by the molecules would be effective for directions parallel to the radii and would be absent for vibration directions transverse to the radii. If the energy of the light corpuscles thus taken up is passed on to the cones nearest to them, the result would be the perception of light for vibration directions parallel to the radii and the absence of such perception for vibration directions transverse to the radii. In other words, in the field of view corresponding to the foveal region of the retina, we would observe a bright brush running parallel to the direction of vibration in the polarised light and a dark brush running transverse to the direction of vibration. This is actually what is observed.

We may remark that the explanation set forth above would cover the details of the picture actually perceived by the observer. It may be mentioned that a colour filter well suited for such observations is a solution of cuprammonium of which the strength is so adjusted that it cuts off the green, yellow and red of the spectrum completely without any sensible absorption in the blue and the violet. A glass tube three centimetres in diameter and one centimetre long fitted with flat end plates and filled with the solution makes a very efficient filter. With the cell and a polaroid held up against the bright sky, the configuration of the brushes can be very conveniently studied. It is readily verified that the dumbell-shaped brushes are confined to a region in the field of view corresponding to the part of the fovea where the nerve fibres as shown in the anatomical drawings run obliquely. The region corresponding to the very centre of the fovea where the dark bright brushes cross is, of course, never quite dark. Its appearance alters with the orientation of the observing polaroid to a certain extent. This indicates that the molecules of the pigment in this region have preferred orientations.

MEASUREMENT OF THE VERTICAL DISTRIBUTION OF ATMOSPHERIC OZONE BY A CHEMICAL OZONESONDE

C. R. SREEDHARAN AND A. MANI

Meteorological Office, Poona

RECENT studies have shown a close relationship to exist between atmospheric ozone and the behaviour of the middle stratosphere, especially at temperate and high latitudes, at times of great dynamic activity. Synoptic observations of the vertical distribution of atmospheric ozone are therefore of great value for the investigations of the general circulation of the stratosphere. It is also of considerable interest to atmospheric physicists working in such fields as radiation, ozone photo-chemistry and climatology. The Umkehr method extensively used in the past for studies of the vertical distribution of atmospheric ozone is indirect, time-consuming and does not provide a detailed and continuous profile. Ozonesondes recently developed for the direct measurement of the vertical distribution of ozone in the atmosphere use optical,[1] electrochemical[2] or chemiluminescent[3] techniques. The present note briefly describes an ozonesonde developed in the Instrument Division of the Meteorological Office, Poona. Results of preliminary soundings at Poona are also presented.

The ozone sensor is a Brewer bubbler type electrochemical cell containing 2 ml. of 2% potassium iodide solution. The cathode is a fine platinum gauze about 5 sq. cm. in area and the anode a piece of silver wire. Ambient air is pumped through the solution at a steady rate by a miniature, constant-volume reciprocating piston pump operated by a miniature 3 V d.c. motor that runs at about 5,000 rpm. A steady polarising potential of 0·42 volts derived from a mercury cell is applied between the platinum cathode and the silver anode in the bubbler. Ozone present in the air sample reacts with the potassium iodide solution as follows:

$$O_3 + 2\,KI + H_2O = O_2 + I_2 + 2\,KOH.$$
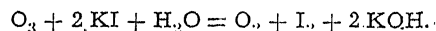
The polarising potential produces a thin layer of H_2 at the cathode. Every free iodine molecule liberated by the ozone reacts with the H_2 causing a depolarisation current of two electrons to flow in the external circuit. For amounts of ozone found in the atmosphere currents up to

$5 \mu A$ are obtainable with a pumping rate of 200 ml./minute.

The telemetering system consists of a temperature-controlled transistorised D.C. amplifier, modulator and UHF transmitter. The amplified bubbler current output from the D.C. amplifier modulates the 72 mc./s. carrier in the range 0 to 200 cycles. The sonde transmits, in addition to the ozone values, the pumping rate, the D.C. amplifier zero, the atmospheric pressure, ambient air temperature, pump temperature and transmitter reference frequency. The various parameters are programmed into the modulator through a commutator operated by the motor through a reduction gearing. The entire system is housed in a thermocole (expanded polystyrene) tube section of 100 mm. wall thickness to prevent the KI solution from freezing. The signal from the sonde is received *via* an omnidirectional antenna on a 72 mc./s. receiver and recorded on a 300 mm. chart on a cycloray recorder.

instrument. Ozone is produced by irradiation of an air-stream by a quartz mercury lamp. The preflight procedure consists of calibrating the sonde using a simple current generator which supplies 0 to 5μ amps in one μ amp steps. Just before the flight the sonde is calibrated and the calibration points are recorded on the chart. For about an hour before the flight the intake tube is connected to a strong ozone source and the pump run from an auxiliary battery. Impurities in the intake tube, the pump and the bubbler are oxdised in this manner.

The complete sonde with the batteries weighs about 2 kg., the weight being considerably reduced by the use of transistors and smaller power supply units.

Data from the sounding is checked by measurement at the ground by a chemical method with Ehmert's apparatus.

The results of two soundings taken on 29-9-1964 and 2-11-1964 at Poona are shown in Fig. 1 where the partial pressure of ozone in

POONA
29-9-64
0021 I. S T
0.1 ATM - CM

BOMBAY
28-9-64
1730 I S T
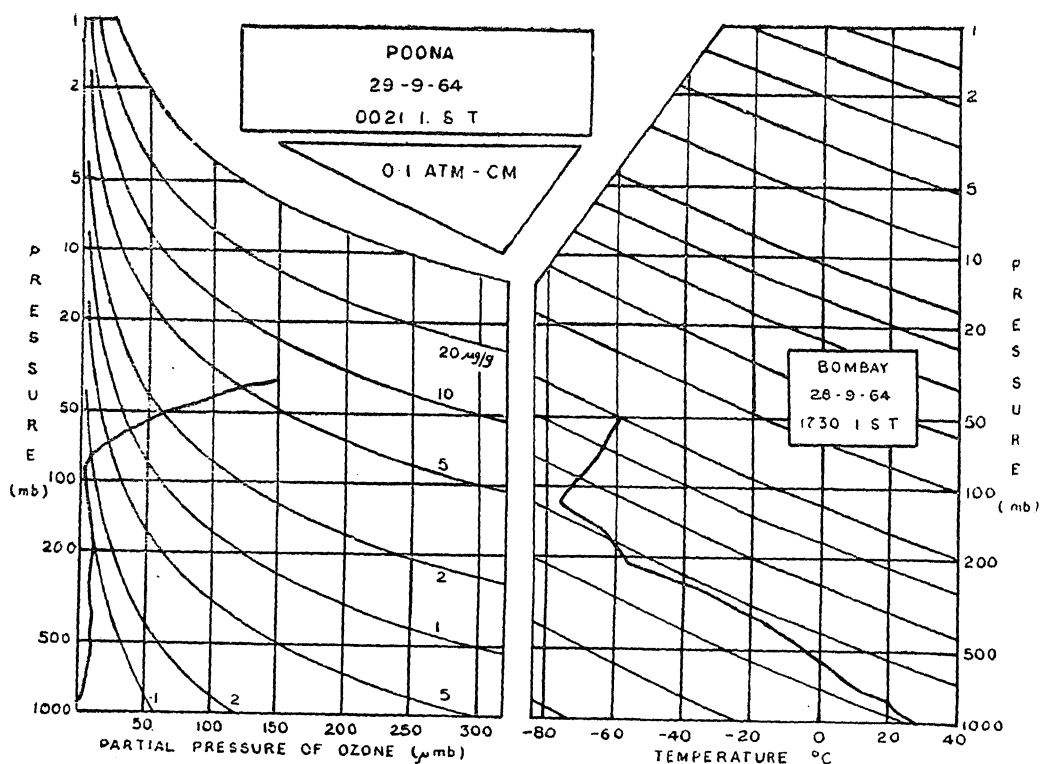
FIG 1(a) — OZONE SOUNDING AT POONA ON 29-9-64

An ozone source is used to precondition the sonde and to adjust the sensitivity of the μ mb. is plotted against pressure in mb. in the left diagram. On the right the vertical profile of
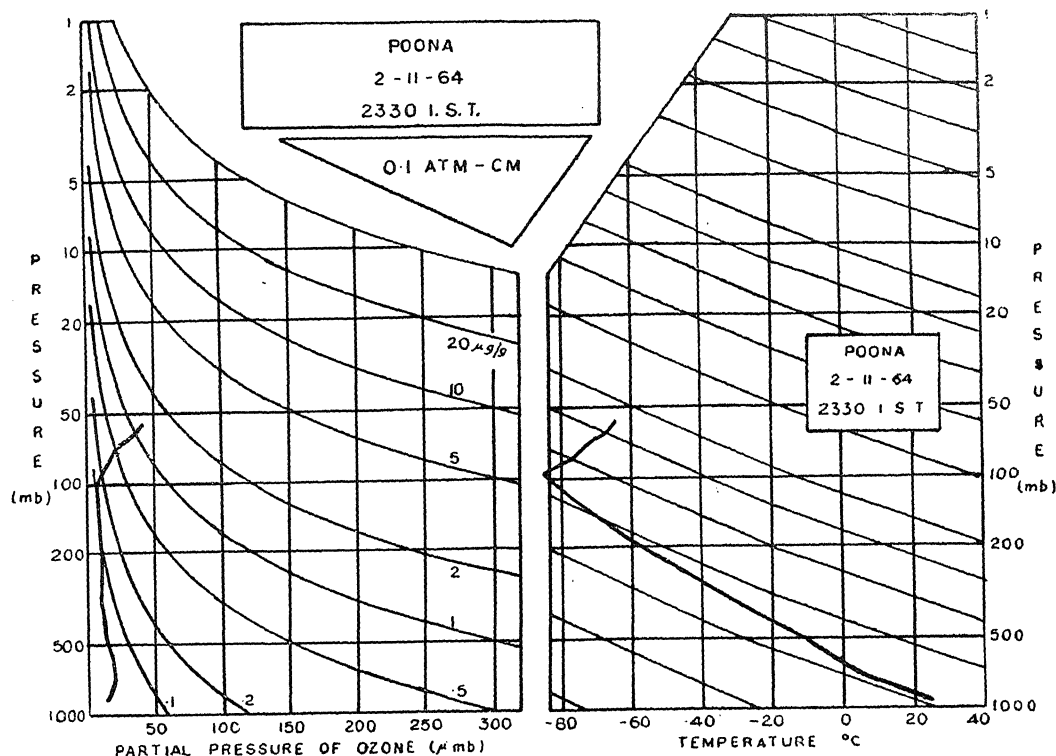
FIG 1(b) – OZONESOUNDING AT POONA ON 2-11-64

temperature is given for the days for Poona and Bombay. The partial pressure of ozone is relatively small at all levels below the tropopause and increases rapidly with height above the tropopause, reaching a maximum at about 25 km. The marked increase at 600 mb. on 2-11-1964 is associated with the anticyclonic subsidence of upper tropospheric air observed on that day. In general the vertical distribution of atmospheric ozone is closely related to the wind field and thermal structure of the atmosphere. Ascent and descent values are in satisfactory agreement.

The ozonesonde was developed at Poona in connection with the programme of upper atmospheric observations to be made during the IQSY. With systematic observations at a number of stations and from a study of the seasonal and latitudinal variations of the vertical distribution of ozone it should be possible to arrive at a

better understanding of the mechanism of ozone changes in the lower latitudes. A detailed and critical study of the performance of the sonde will be published elsewhere.

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RADIOCARBON DATES OF SOME NEOLITHIC AND EARLY HISTORIC SAMPLES

D. P. AGRAWAL AND S. KUSUMGAR

Tata Institute of Fundamental Research, Bombay-5

WE present here radiocarbon dates of samples obtained from the neolithic site of Burzahom, Kashmir, and from Hetimpur and Kausambi, both early historic sites in Uttar Pradesh.

As pretreatment of the sample differs from laboratory to laboratory, our procedures are given briefly. All samples were first manually cleaned to remove soil, rootlets, etc., and then digested with 1% HCl to remove carbonates. NaOH pretreatment was given only when the charcoal was sufficiently hard to stand it; wherever this treatment has been given it has been mentioned in the attached list. The techniques adopted have been described in detail by Kusumgar *et al.* (1963).

For the modern carbon value we have taken 95% of the value C^{14}/C^{12} in the N.B.S. oxalic acid which had been calibrated against pre-1900 wood. For each sample two dates, in years B.P. (before present), are given. The first date is based on a value of 5568 ± 30 yrs. for the half-life of radiocarbon; the second date, given within brackets, is based on half-life of 5730 ± 40 yrs., which is "regarded as the best value now obtainable" (Deevey *et al.*, 1964). For all intercomparisons dates based on the same half-life value should be used. To convert dates to the A.D./B.C. scale, 1950 A.D. should be used as the reference year (Deevey *et al.*, 1964.)

ACKNOWLEDGEMENTS

C^{14} DATES WITH SAMPLE DESCRIPTIONS

Burzahom, Kashmir, India

Burzahom (Lat. 34° 10' N, Long. 74° 54' E.), District Srinagar, is the northernmost excavated neolithic site of India. This Neolithic Culture has no parallel in the country; some Chinese affinities have, however, been pointed out (Gupta, 1964). The site is being excavated by Shri T. N. Khazanchi since 1960-61 (Ghosh, 1960-61). Samples submitted by Shri A. Ghosh. Comment: The antiquity of the site seems to

extend up to the last quarter of the third millenium B.C.

TF-14, Neolithic Period, 3860 ± 340 (3975 ± 350)

Charcoal with mud from Trench SE, Locus A1, Depth 2·1–3 m. Wet combustion of sample carried out. (A few rootlets were visible in the sample.) As the sample was small it was counted by mixing with anthracite C_2H_2.

TF-127, Neolithic Period, 3935 ± 110 (4050 ± 115)

Charcoal from Trench BZH-1/62, North Extension, Locus XIX_x-$XXII_x$ Layer 13, Depth 2·9 m. NaOH pretreatment was also given.

TF-123, Neolithic Period, 4055 ± 110 (4175 ± 115)

Charcoal from Trench BZH-3/61, Locus B2(NE), Layer Pit C, Depth 2·8–3·5 m. NaOH pretreatment was also given.

TF-128, Neolithic Period, 4205 ± 115 (4325 ± 120)

Charcoal from Trench BZH-1/62, North Extension, Locus $XXII_x$-$XXIII_{/}$ Layer 13, Depth 3·9 m. NaOH pretreatment was also given.

Hetimpur, Uttar Pradesh, India

This site is located in District Varanasi. The site seems to have been vacated by the megalithic (pre-Iron) folk because of the impact of the historical people represented by the occurrence of N.B.P. Ware. Hetimpur excavations are being conducted by a group from the Allahabad University under the direction of Prof. G. R. Sharma, who submitted the samples.

TF-177, N.B.P. Ware Period, 1820 ± 100 (1870 ± 105)

Charcoal from Trench HPR-I(V), Locus A2, XII-XIII, Pit B sealed by Layer 4, Depth 1·2 m., Field No. HPR-I(V)63/2003.

TF-176, N.B.P. Ware Period, 2000 ± 100 (2055 ± 105)

Charcoal from Trench HPR-I, Locus A2, IX-XIV, Layer 4, Depth ·46 m., Field No. HPR-I(V)-63/2002.

Kakoria, Uttar Pradesh, India

TF-183, Megalithic Habitation, 200 ± 95 (205 ± 100)

Charcoal from Kakoria (Lat. 25° 3' N, Long. 83° 11' E.), District Varanasi, Trench KKR-II, Locus SAI, 0-14, Layer 4, Depth ·76 m., Field No. KKR-II(V)63/1507. (Few rootlets were visible in the sample.) Submitted by Prof. G. R. Sharma. Comment: The excavator had indicated the possibility of having mistaken old black

roots for charcoal while collecting samples at the site. More samples from the site are being measured to ascertain the true age.

Kausambi, Uttar Pradesh, India

Kausambi (Lat. 81° 23′ N, Long. 25° 20′ E.), now known as Kosam, District Allahabad, is located on the northern bank of Yamuna. According to the Puranic tradition the capital of the Pandavas was shifted from Hastinapur to Kausambi at the time of Nichaksu, fifth in descent from Parikshit, the grandson of Arjuna. The site is being excavated (Sharma, 1960) since a decade by a group from the Allahabad University under the direction of Prof. G. R. Sharma, who submitted these samples.

TF-103, Period III,   2295 ± 105 (2360 ± 110)

Charcoal from the Ghositaram area of Kausambi, Trench KSB-GR, Locus YZ2, 2-3, Pit C sealed by Layer 18ABK, Depth 3 m., Field No. KSB/63/GR-106. (A few rootlets were visible in the sample.) Comment : The sample has been attributed to the last phase of N.B.P. Ware.

TF-104, Period III,   2150 ± 105 (2220 ± 110)

Charcoal from Trench KSB/GR, Locus YZ2, 2-3, Layer 22BK, Depth 2·4 m., Field No. KSB/63/GR-107. (A few rootlets were visible in the sample.) Comment : The sample has been attributed to the middle phase of N.B.P. Ware.

TF-105, Period III,   2220 ± 110 (2285 ± 115)

Charcoal from Trench KSB/GR, Locus YZ2, 1-2, Pit A sealed by Layer 21 BK, Depth 2·4 m., Field No. KSB/63/GR-108. (A few rootlets were present in the sample.) NaOH pretreatment was also given. Comment : The sample has been attributed to the middle phase of N.B.P. Ware.

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INDIAN ACADEMY OF SCIENCES : 30TH ANNUAL MEETING

THE Thirtieth Annual Meeting of the Indian Academy of Sciences was held on 25, 26 and 27 December 1964 in Poona under the auspices of the Poona University. The three-day session started with the inaugural function held in the N. M. Wadia Amphitheatre of the Fergusson College at which Dr. N. V. Gadgil, Vice-Chancellor of the Poona University, welcomed the Fellows and Delegates to the meeting. Sir C. V. Raman, in his Presidential Address on "Vision and the Nature of Light", dealt with his most recent investigations on the relation between the physical nature of light and the physiological sensations excited by its incidence on the retinæ of our eyes. (A summary of the address appears below.)

The scientific meeting in Section A was held in two sessions on the 26th. The first session began with a paper by Dr. S. Bhagavantam on "Crystal Symmetry and Magnetic Properties". There was a symposium on meteorology over which Mr. P. R. Krishna Rao, Director-General of Observatories, presided. The symposium was opened by Dr. K. R. Ramanathan with his talk on "Stratosphere and Mesospheric Meteorology".

Section B met in two sessions on the 27th and Dr. N. K. Panikkar, Director, Indian Programme of the International Indian Ocean Expedition, presided. The meeting was initiated by Dr. M. S. Swaminathan, Head of the Division of Botany, Indian Agricultural Research Institute, New Delhi, with his lecture on "Experimental Manipulation of Genes", in which he explained the latest researches in this field of study with special reference to the work in progress on mutations and plant breeding at the Co^{60} gamma garden in the Agricultural Research Institute. This was followed by a talk by Dr. E. S. Narayanan on "Genetical Behaviours of the Mulberry Silkworm".

There were two public lectures during the Academy session. The first was by Dr. S. Bhagavantam on "Lasers and the Raman Effect" on the 26th evening, and the second by Dr. N. K. Panikkar on "The Indian Ocean" on the 27th evening.

The following papers were presented and discussed at the symposium on meteorology : "Jet Streams in Relation to Aviation over India" by Mr. P. R. Krishna Rao ; "A Preliminary Study of the Indian SW Monsoon in Relation to the Dynamics of Jet Streams over the World" by Mr. C. Ramaswamy ; "Meteors and the Upper Atmosphere" and "Seasonal Variations in Zonal and Meridional Circulations over India and Neighbourhood" by Dr. R. Ananthakrishnan ; "A Numerical Prediction Model for the Indian Region" by Dr. P. R. Pisharoty and Mr. G. C.

Asnani; "Evaporation over the Arabian Sea" by Dr. P. R. Pisharoty and Mr. C. R. V. Raman; "Infra-Red Radiative Flux Measurements in the Atmosphere over Poona" by Miss Anna Mani; "Structure of a Monsoon Depression" by Mr. M. Gangopadhyaya; "Climatic Changes with Particular Reference to India" by Mr. K. Nagabhushana Rao.

The following papers were presented and discussed at the meetings in Section B. "Work of the Indian Station of the Commonwealth Institute of Biological Control" by Dr. V. P. Rao; "The Structural Basis of the Human Mind" by Dr. Dev Satya Nand; "Cell Contacts and Tissue Organisation" by Prof. E. J. Ambrose; "Recent Advances in Antibiotics" by Dr. N. Narasimhachari.

The following is a summary of the Presidential Address on "*Vision and the Nature of Light*": The passage of light through the dioptric media in our eyes and the formation of optical images of external objects on their retinæ have necessarily to be described in terms of geometrical concepts and the wave-theory of light. But these concepts cease to be relevant in all considerations regarding the visual perception of these images. Here we have to proceed on the basis of the ideas introduced by Einstein in the early years of the present century, *viz.*, that light is corpuscular in its nature, that its interactions with material bodies involve the transference of energy in discrete units which are proprotional to the frequency of the optical vibration, that such transference is not a continuous process but consists of individual events, that whether such transference occurs or not is a matter of chance, and hence that the observable phenomena arising from such events can only be described in statistical terms.

Observational proof of the considerations indicated above is forthcoming when an observer views a uniformly illuminated surface situated at a sufficient distance from himself. He then notices that the luminosity does not appear uniform or static but exhibits fluctuations in the entire area. The nature of the effects noticed is found to depend on the strength of the illumination, its spectral character and the distance of the observer from the screen. The fluctuations are conspicuously noticeable even when the illumination is thousands of times more powerful than the limit at which the sensations of light itself vanishes. These fluctuations find a natural explanation in terms of the corpuscular nature of light and the discrete structure of the retina with its mosaic of visual receptors. The corpuscular nature of light likewise plays

an essential role in our ability to perceive the forms of objects. It is clearly necessary that the corpuscles of light reach the individual receptors of the retina from the elementary parts of external objects in sufficient numbers and sufficiently frequently for a coherent picture of the same to be formed and transmitted to the cerebral centres. These requirements would not be satisfied unless the intensity of the illumination is adequate. If this is not the case the picture perceived would necessarily be of a fragmentary and fluctuating nature, resulting in a rapid fall of what is usually known as visual acuity. Such fall is a consequence of the fluctuating character of the picture of the external objects formed on the retina.

The corpuscular nature of light further results in bringing the sensations of luminosity and of colour into close relationship with each other. When the flux of light reaching the retinal receptors is very small, the sensations which are excited would necessarily be weak and this would be the case alike for the chromatic sensation and for the sensation of brightness. In other words, when the illumination is feeble, so also would be the perceived colour. This is actually found to be the case and such interdependence of luminosity and chromaticity is an inherent characteristic of vision which arises from the nature of light itself.

It follows as a consequence of the corpuscular nature of light that we should recognise the sensations excited by monochromatic light as the fundamental physiological sensations. Further we are not entitled to assume that the visual sensations excited by polychromatic radiation can be deduced by a simple summation of the sensations excited by the individual spectral components of such radiation. Physiological considerations indicate that the sensations actually experienced would differ greatly from the consequences of any such assumption and that in particular, the masking or suppression of weaker by stronger sensations would play an important role. It follows that the so-called trichromatic hypothesis and the ideas regarding colour synthesis based on that hypothesis are invalid and should be laid aside. The colour sensations excited by polychromatic radiations have been explored in the present investigation in a very large number of cases of the most diverse sorts. The observations provide us with ample material on which it is possible to base an acceptable picture of the sensations resulting from the visual synthesis of colour.

LETTERS TO THE EDITOR

EFFECTS OF L-SHELL ELECTRONS ON THE POLARIZATION OF ELASTIC SCATTERING OF GAMMA RAYS

IN a previous communication[1] the results of the measurement of the linear polarization of the elastic scattering of 662 keV gamma rays from lead at 64° were reported and it was shown that the incomplete isolation of coherent scattering from the incoherent scattering lowers the experimental results in comparison with the theoretical predictions[2] and that either complete isolation of coherent scattering or correction for the contribution of incoherent to coherent scattering should give correct results in agreement with theory ; this was in contradiction with the suggestion of earlier workers[3] who ascribed the previously observed[3,4] lower values to the contribution of L-shell electrons. We have extended the measurements to other gamma ray energies and angles and investigated the influence of L-shell electrons in more detail. The method of measurements was the same as described previously.[1] The effect of the contribution of L-shell electrons was estimated as described below.

1. If according to the assumption of Bernstein and Mann[5] the spin flip and non-spin form factor contribution due to L-shell electrons are taken in the same ratio as the corresponding contributions for the K-shell electrons, the contribution of L-shell electrons does not have any effect on the percentage polarization and the final value is the same as calculated from K-shell data of Brown et al.

2. However, if according to the suggestion of Brown and Mayer,[2] that at large values of momentum transfer, the contributions of non-spin flip components may be neglected in comparison with the spin flip contribution, the values of percentage polarization of the elastic scattering for K-electrons will be affected by the contribution of L-shell electrons. The results are summarised in Table I.

The comparison of experimental values with the theoretical calculations confirms our previous results that incomplete isolation of coherent scattering from incoherent scattering tends to lower the observed values of percentage polarization and the effect of L-shell electrons, if any, is small and does not show itself above experimental errors.

TABLE I

Scattering angle	Gamma ray energy (Mev)	Experimental	Percentage Polarization (Rayleigh + Thomson Scattering) Theoretical		
			Without L-shell contribution	L-shell Bernstein and Mann	L-shell Brown and Mayers
64°	0·662	96±8*	91	91	96
		94±9†			
		88±10†			
	1·25	100±15	93	93	90
90°	0·662	78±8*	78·5	78·5	69
		90±14†			
	1·25	15·7±6·4	17·2	17·2	14
93·5°	0·280	95±6*	90	90	87
120°	0·280	42·5±5·5*	45	45	41
	0·662	28·4±6·5*	..		
		33·7†	25·3	25·3	21

* Data obtained with almost complete isolation of coherent contribution from incoherent contribution.

† Data obtained after correcting for the contribution of incoherent to coherent scattering under experimental channels.

Physics Department,   S. ANAND.
Punjabi University,   M. SINGH.
Patiala, October 29, 1964.   B. S. SOOD.

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UNUSUAL FINDING OF METALLIC LEAD IN THE ELEPHANT TUSK

THE use of ivory in inlaying work of art for decorative purposes is well known. In industry, little is wasted of this valuable material.

For minimal wastage of this material, a new technique has been adopted by the author to cut uniformly 100–200 micron thickness after slightly decalcifying the whole tusk in formic acid. The material is clamped to a giant microtone and the sections are taken at a desired thickness. Recently a part of tusk measuring 4¾" in diameter and 6" in length was received from an industry for similar sections by the author. Longitudinal sections were taken to a depth of about 2½". At this level the cutting
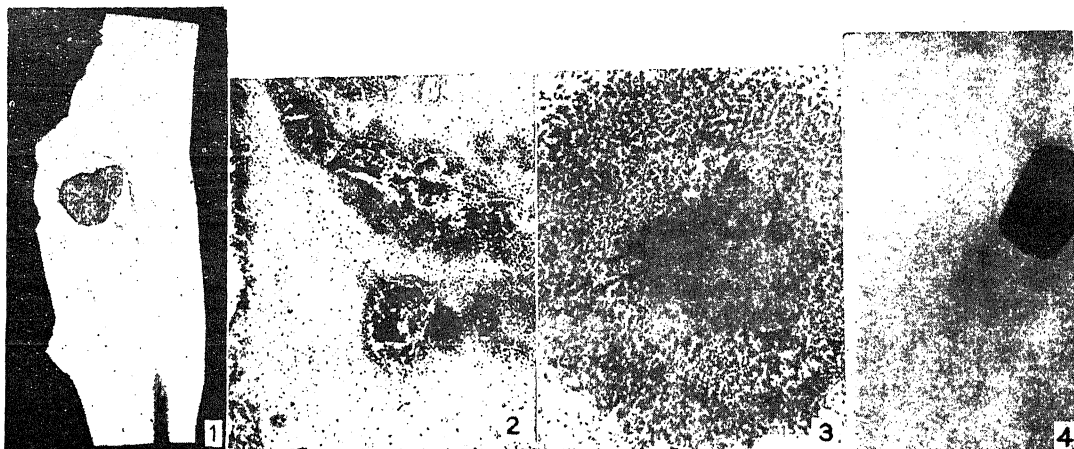
FIGS. 1–4. Fig. 1. Photograph of the tusk longitudinally cut showing the embedded lead piece at the depth of $2\frac{1}{2}''$. Fig. 2. Section of the tusk showing higher concentration of lead particles just around the lead piece. Chromic acid stain, × 100. Fig. 3. Section of the tusk showing a single collection of lead particles at the border of the lesion. Chromic acid stain, × 400. Fig. 4. X-ray of the tusk showing the penetration of the whole lead piece.

knife struck a metal piece. The diameter of the metal piece was $\frac{1}{2}''$. Attempts were made to identify the metal after microincineration. The metal was found to be lead in the form of yellow, rather opaque crystals, soluble in dilute nitric acid blackened by ammonium sulphide. There was definite lesion of the tusk right round the lead piece and the lesion ran about 3″ below 1″ above the metal piece. Histological sections were taken at 15 micron thickness at different parts of the lesion to study the distribution of the metallic substance. The sections were treated with chromic acid. Microscopically the particles were identified as lead. The concentration of the lead particles seemed to be higher just around the lead piece and was considerably less at the borders of the lesion. Figure 2 shows higher concentration immediately next to the lead piece and Fig. 3 shows single collection of lead particles far below the location of the lead piece. X-ray pictures revealed that the size of the lead piece was about 1″ in depth embedded in an irregular manner.

In this specimen, the unusual penetration of the foreign body into the middle of the tusk without any external injury and therefore without any visual evidence of retained foreign body is a feature not seem to have been recorded before in the literature, and at the moment an explanation for this observation is baffling.

Central Food Technological   A. PAUL JAYARAJ.
   Research Institute,
Mysore-2, *November 7, 1964.*

BEHAVIOUR OF CATALASE IN CORN (*ZEA MAYS*) AND SOYBEAN LEAF TISSUES

IT is reported that catalase from different animal tissues and bacterial cells did not have the same activation energy and behaved differently. The activation energy of horse erythrocyte catalase, of beaf liver catalase, and of bacterial catalase is not the same for all (Glick, 1954). In his studies on catalase-chlorophyll relationship in barley seedlings, Appleman (1952) found that catalase in etiolated seedlings had a lower activation energy than the catalase in green seedlings. In order to investigate how the catalase in monocotyledon and dicotyledon plants behaved an experiment was carried out.

Experimental material.—Corn (*Zea mays*) and soybean plants were raised in solution culture under controlled conditions of nutrient levels duration and intensity of light and temperature in a plant growth chamber. Three weeks after planting, replicated leaf samples were collected from both the sets of plants. Careful consideration was given for proper sampling of leaf tissue since the catalase activity has been found to vary markedly from the base to the tip of the leaf (Euler, 1948). The sampling was done in a cold room by clean hands and at no stage was there any contamination from metal.

Enzyme preparation.—One gram of aliquot portion of leaf sample was transferred to a clean chilled porcelain mortar containing 5 ml. tris buffer ($0.2 M$ tris in $0.3 M$ sucrose solution,

pH adjusted to 7·0). A pinch of acid-washed fine sand was added and the leaf material was trichurated until a fine suspension of leaf homogenate was obtained. After allowing the sand to settle, the suspension was tilted on one side and transferred to a 50 ml. flask by means of a mechanical pipette. The mortar was rinsed several times with buffer solution and all washings transferred to the flask and finally made to volume. All the operations, including weighing, were done in the cold room and only glass-redistilled water was used.

Measurement of the enzyme activity.—Catalase activity was measured manometrically using a Warburg apparatus provided with a temperature control and shaking mechanism. Catalase in the leaf homogenate was allowed to react with hydrogen peroxide at a constant temperature and volume and the liberated oxygen was measured on the manometer.

One ml. of the leaf homogenate and 0·2 ml. of $0·1 N$ H_2O_2 were placed in the main vessel and sidearm respectively of the Warburg flask. After equilibrating for five minutes, H_2O_2 from the sidearm was tipped into the vessel containing the enzyme preparation. This was the zero time. Manometer readings were then recorded at an interval of two minutes each for a period of twenty minutes. The thermobarometer contained 1 ml. of buffer solution and 0·2 ml. of $0·01 N$ H_2O_2. The reaction was allowed to proceed at a constant temperature of 30° C. and a shaking rate of 120 cy./min. Results of the experiment are given in Table I and are expressed as microlitres of oxygen liberated from 1 mg. dry weight during 20 minutes.

TABLE I

Catalase activity in corn and soybean
leaf tissues*

Replications	Corn	Soybean
	μl. oxygen/mg. dry wt./20 minutes	
1	8·05	9·17
2	8·84	7·78
3	9·57	11·44
4	8·93	8·69
5	8·14	9·11
6	9·45	9·90
Mean	8·83	9·34

* Oxygen liberated in presence of enzyme preparation from hydrogen peroxide.

The catalase activity in soybean leaf tissue was slightly more than in corn leaf tissue. In the same period of time while soybean leaf tissue liberated 9·34 microlitres oxygen per mg. dry

wt., corn leaf tissue under similar conditions liberated 8·82 microlitres oxygen per mg. dry wt. Here a comparison is made between the volumes of oxygen liberated within a period of twenty minutes in both the cases. Catalytic reaction of the catalase enzyme with H_2O_2 is of the first order (Glick, 1954). It would be, therefore, pertinent to compare the magnitude of the volume of oxygen liberated at the end of the period when the first reading was recorded. In the actual procedure the first measurement after the zero time was made at the end of two minutes. In Fig. 1 are plotted microlitres oxygen liberated against time, of the catalase reaction from corn and soybean leaf homogenates.
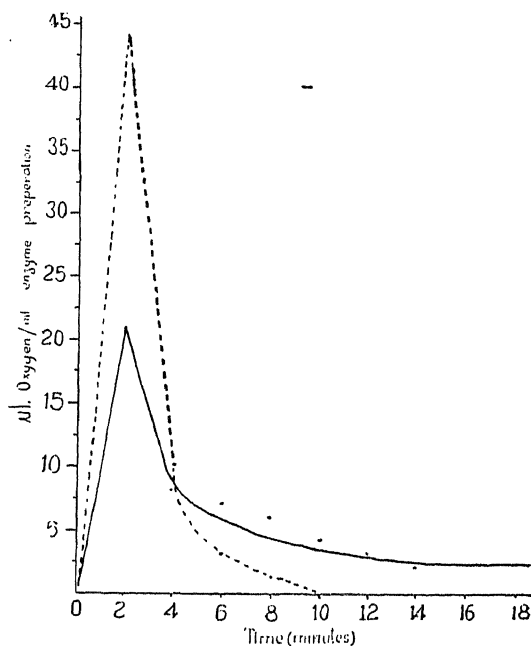
FIG. 1. Catalase activity in corn and soybean leaf enzyme preparations.

Although the total amount of oxygen accumulated at the end of the experiment was almost the same in both the samples, in soybean, at the end of first two minutes, oxygen liberated was twice as much as in corn. In the second interval it suddenly dropped showing a typical first-order reaction ; and it reached zero level at the end of the fifth interval (10 minutes). However, in corn, oxygen was continued to be liberated even after the fifth interval.

The above observations lead to the conclusion that the catalase in soybean leaf followed the first-order reaction more rigidly than the one in corn, thus indicating difference in the

behaviour of catalase in monocotyledon and dicotyledon leaf tissues.

Agronomy Department,   N. G. PERUR.
Utah State University,   R. L. SMITH.
Logan, Utah, U.S.A.,   HERMAN H. WIEBE.
August 20, 1964.

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TEAK OIL FROM *TECTONA GRANDIS* LINN.

TEAK (*Tectona grandis* Linn. ; Family, *Verbinaceæ*) is one of the important commercial timbers of India and other tropical countries. It is valued for its durability as it is immune to insect and fungus attacks and resists wood rot. This inherent quality of teak wood is largely attributed to the presence of oil. The exact nature of the oil is not known so far and the literature on this aspect is very scanty and confusing. A reference to the works on Indian Forestry reveals that teak wood contains an oil which is easily perceptible to the touch and is preservative in character.[1] This oil is used medicinally, as a substitute for linseed oil and as a varnish,[2] apparently indicating the nature of the oil to be as that of fixed oil. Although the woods yield essential oil on distillation, no trace of essential oil was detected on distillation of teak wood.[3] Studies on the chemistry of teak heartwood by Romanis[4] and Kafuku and Sebe have revealed the presence of tectoquinone (2-methyl anthraquinone) in the steam distillate of resinous material obtained by extracting the saw dust with organic solvents. No work has, however, been reported so far on the oil. An investigation has been undertaken to study the chemistry of teak wood and also to ascertain the exact physico-chemical nature of the oil. The interim results are presented in this paper.

Teak wood on steam distillation yields 0·15% of an oil along with a solid compound (m.p. 178–79°), identical with tectoquinone of Kafuku and Sebe.[5]

Fresh shavings (10 kg., moisture, 10·15%) from a log of a brightly coloured teak wood were distilled with steam at a pressure of 2·81 kg./cm.^{2} (40 lb./in.^{2}) for 4 hours. The distillate was collected in a florentine flask and employing the 'F.R.I. Oil Trap' for the recovery of last traces of the oil in the overflowing water. On working up with ether, a thick yellowish-brown oil was obtained which on keeping deposited an orange coloured solid. By repeated congealing and filtration under suction, the solid was separated from the oil. The oil was obtained in 0·15% yield (zero moisture basis) and had the following physico-chemical characteristics :

Colour : Yellowish-brown; Sp. gr. at 28° ; 0·9405 ; Ref. index at 28° : 1·5023 ; Opt. rot. at 28° : −2·20° ; Acid value : 3·45 ; Sap. value : 17·89 ; Sap. value after acetylation : 96·42 ; Sol. in 95% alcohol : 1 : 20.

The solid was purified by chromatography over Brockmann's alumina and on crystallization from alcohol separated as light yellow fibrous needles melting at 178–79°. It agrees in all tests with 2-methyl anthraquinone (tectoquinone) of Kafuku and Sebe.[5] With 2 : 4 dinitrophenylhydrazine, it formed a 2 : 4 dinitrophenylhydrazone, crystallized from alcohol and ethyl acetate, melting at 254–55°. On boiling with acetic anhydride, pyridine and zinc, it gave the diacetate of β-methyl anthrahydroquinone melting at 221–22° (m.p. reported in literature[5] 216–17°).

Grateful thanks are due to Shri O. P. Sharma for his technical assistance.

Forest Research Institute,   R. M. BERI.
P.O. New Forest, Dehra Dun,   M. G. KARNIK.
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A PROBABLE PLANT INDICATOR FOR ZINC MINERALISATION IN THE ZAWAR Pb-Zn BELT, UDAIPUR DISTRICT, RAJASTHAN

IN the Zawar Pb-Zn belt the ore, consisting mainly of an assemblage of sphalerite, galena and pyrite, occurs as replacement along shear zones, fractures, lithological contacts and fold hinges exclusively in dolomite. The dolomites are intercalated with orthoquartzite, feldspathic quartzite, phyllite, slate, graywacke and epiclastic conglomerate. These Aravalli sediments have undergone regional metamorphism in green schist facies conditions.

Surface expressions of mineralisation like diagnostic gossan zones are absent or very poor.

The nature of the host rock, absence of open fractures and consequent lack of porosity and permeability, and the rugged terrain conditions are responsible for this phenomenon. The dolomite bands, in which Pb-Zn sulphides are emplaced, form strike ridges of moderate to steep slope. Residual soil cover is very thin and impersistent on the ridge tops. Limonite and siderite veins are seen on the outcrops of dolomite. Limonite is compact, devoid of box-work, and varies in colour from dark tan to ocherous yellow. Siderite is coarse crystalline, with shades ranging from tan brown to reddish brown. The physical characters do not give any clue as to whether these are derivatives of pyrite or Pb-Zn sulphide. Systematic geochemical sampling has, however, been reported to yield data as to the parentage by anomalous content of Pb and/or Zn (Straczek and Ganeshan, 1960).

The entire zone has been prospected and mined by ancient workers. The chains of these workings serve as guides to mineralisation, and at the same time introduce limitations in geochemical survey by enhancing the chances of contamination.

It is possible to isolate the probable mineralised stratigraphic horizons of dolomite on the basis of air photo mapping but the necessity of a ready reckoner is very much felt to eliminate barren zones in the dolomite horizons and demarcate blocks for detailed exploration.

Normally geological work in these areas is conducted during the winter and summer months when vegetation is sparse. During the period August 27 to August 31, 1964, the author revisited some parts of the Zawar belt, *e.g.*, Hameta mogra near Goira village (24° 23′ : 73° 39′) and the Mochia and Balria mogras, 4·5 km. S.E. of Hameta mogra and where the producing zinc-lead mines are located. During the monsoon, the valleys and hills are covered by lush green vegetation. In the Hameta mogra, various types of flowering plants and shrubs grow in abundance of which a species of balsam with single-whorled purple flowers shows a striking selectivity for dumps and outcrops of sphalerite. A reconnoitry tour in the Mochia-Balria (*i.e.*, in the producing mine area) revealed the same distribution pattern. Enormous population of the species was found along the southern flank of the Mochia and Balria.

It is unlikely that the plant favours the soil derived from dolomite because in areas where dolomite is barren of zinc sulphides, the species does not grow. The presence of Pb is perhaps

also not necessary as in the Hameta area sphalerite is the dominant sulphide, and galena is present only in minor proportion.

Table I gives the details of this plant species,

TABLE I

Element	Local/ Universal	Family	Genus and species	Common name	Locality
Zn	U	Violet	*Viola cala-minera (Lutes)*	Zinc violet	Belgium Germany
	L	Saxifrage	*Philadel-phus* sp.	Mock orange	Washington
	L	Geraniaceae	*Impatiens balsamia*	Balsam	Zawar belt

and of others reported from Europe and America (Hawkes and Webb, 1962, p. 312) as zinc-indicator plants.

The preliminary empirical data indicate that the coincidence between the distribution of *Impatiens balsamia* and Zn mineralisation in the Zawar belt is unlikely to be accidental. Systematic search will be conducted during the next monsoon to establish the relationship.

Not much data are available on geobotanical prospecting for metals in India. Indicator plants, once recognised, give a direct clue to the areas of possible mineralisation.

Bairathi Bhawan,   B. C. PODDAR.
Prithviraj Marg,
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ON THE SUSCEPTIBILITY OF *MACACA MULATTA* TO INFECTION WITH *SCHISTOSOMA INCOGNITUM*

WHILE human schistosomiasis, believed to be schistosomiasis hæmatobia, is endemic only in a small village in Ratnagiri District of Maharashtra (Gadgil and Shah, 1952), animal schistosomiasis is prevalent throughout this country. At least eight species of schistosomes of domesticated mammals occur in India (Srivastava 1962). Both from the veterinary standpoint

whether these animal schistosomes are of any zoonotic importance. *Schistosoma japonicum* parasitises both man and a large number of species of domestic and wild mammals in China, Japan and certain other countries in the Far East. *S. bovis*, a parasite of domestic and wild mammals in southern Europe, Africa and South-West Asia, has been reported from man in several parts of Africa (Blackie, 1932 ; Kisner, et al., 1953 ; Pitchford, 1959). *S. rodhaini*, a parasite of wild rodents, has also been reported to infect man in the former Belgian Congo (D'Haenes and Santale, 1955). Information on this aspect of Indian species of animal schistosomes is very scanty (Cawston, 1925 ; Porter, 1926) and of doubtful validity (Fairley, 1951). Experiments with monkeys provide a reliable method of determining the potential importance of mammalian schistosomes as systemic parasites of human beings. Fairley and his associates (Fairley, 1927 ; Fairley, Mackie and Jasudasan, 1930) reported such a study in this country. They showed that *Schistosoma spindale* Montgomery (1906) was able to reach the mesenteric, portal and pulmonary veins of *Macacus sinicus*. Many young worms were present in the vessels 10 days after exposure to the cercaria. However, they were soon destroyed and only defunct worms found on the 22nd day. In none of the animals did the parasite live up to maturity. The susceptibility of *Macaca mulatta* to infection with *Schistosoma incognitum* Chandler (1926) (Syn. *S. suis* Rao and Ayyar, 1933) is reported here.

Thirteen monkeys of both sexes and of approximate age of 3 months to 3¼ years were used. The cercariæ of *S. incognitum* were obtained from naturally or laboratory-infected *Lymnœa luteola* Lamarck. The naturally infected snails were collected from a tank frequented by infected pigs. The miracidia for laboratory infection of snails were furnished by an experimentally infected dog. Each monkey was exposed to the cercariæ percutaneously by dropping a cercarial suspension of known concentration onto areas of the groin and allowing 15 minutes for the cercariæ to penetrate. The animals were secured manually and no anæsthetic was used. The total number of cercariæ employed per monkey generally varied from 1,000 to 2,500. In one animal, which was exposed to the infection 3 times during a period of about 1½ years, a total of 6,400 cercariæ were used. The number of snails furnishing the cercariæ varied from 4 to 60.

When examined at various intervals after exposure, 6 of the 13 monkeys were found to harbour *S. incognitum*. The infection proved to be fatal to two of the monkeys. One of these, which died 47 days after exposure, was found to harbour 63 male and 37 female specimens of the schistosome in its intrahepatic portal vessels and 2 males and 2 females in its mesenteric veins. All the worms were mature. Press preparation of the liver tissue showed many typical eggs of *S. incognitum*, some of which contained almost fully formed miracidia, while many others were immature. Eggs could not be detected in the intestinal wall or the fæces. The percentage of cecaria which could be recovered as worms in this animal was 10·4. The other animal died 20 days after exposure and was found to harbour 400 immature schistosomes of both sexes in its intrahepatic vessels and 8 specimens in the spleen. The percentage of worm recovery was 22·7. The rest of the positive monkeys were found to be quite resistant. Only 1 to 6 immature schistosomes could be recovered from their intrahepatic portal vessels at autopsy 41 to 48 days after exposure. The percentage of worm recovery in these animals varied from 0·04 to 0·3. Of the remaining 7 monkeys, 6 were examined 42 to 48 days after exposure and one, 551, 122 and 32 days after the first, second and third exposures, respectively. All of them were found to be totally free from living schistosomes or their eggs. Press preparations of the liver, however, showed evidences of the destruction of the parasites in certain cases.

The present study indicates that *S. incognitum* is a schistosome of zoonotic importance. Experimentally, it has been shown to have a much wider definitive host range than any other mammalian schistosome occurring in India (Sinha and Srivastava, 1956). A detailed account of this work will be published elsewhere.

Division of Parasitology,   S. C. Dutt.
Indian Veterinary Res. Inst.,
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ON LANCET FISHES OF THE GENUS *ALEPISAURUS* LOWE FROM THE INDIAN OCEAN*

A PERUSAL of the literature shows that up to now only one species of lancet fish *Alepisaurus ferox* Lowe has been recorded from the Indian Ocean (Barnard, 1925; Smith, 1936, 1961). Recent reports by Gibbs (1960) indicate that two species, *A. ferox* Lowe and *A. brevirostris* Gibbs (1960), occur in the North-Western Atlantic. *A. ferox* has also been recorded from several localities from the Atlantic and at present the following are considered synonyms of this species : *Alepisaurus azureus* Valenciennes (1849) from Canary Islands ; *Alepisaurus richardsoni* Bleeker (1855) from Van Diemens Land [based on Richardson's (1844) description of a head]; *Alepisaurus altivelis* Poey (1861) from Cuba ; *Alepidosaurus borealis* Gill (1863) from the Pacific ; *Alepidosaurus serra* Gill (1863) also from the Pacific ; *Alepidosaurus pœyi* Gill (1863) from Cuba (based on drawings of a specimen made by Poey) ; and *Alepidosaurus œsculapius* Bean (1883) from the Pacific. For discussion on these synonyms reference is invited to Gibbs (1960).

A. brevirostris Gibbs has thus far been known only from North-Western Atlantic, the holotype having been caught in longline at 38° 49′ N., 64° 02′ W. and paratypes taken from several localities from this general area of the Gulf Stream.

From January to May 1964 while carrying out longline fishing for tunas and marlins in the Arabian Sea, Western, Southern and Central parts of the Indian Ocean and the Maldive-Laccadive Seas from the U.S. Research Vessel ANTON BRUUM, a large series of over 100 specimens of *A. ferox* were caught from 26 longline stations and six specimens of *A. brevirostris* were caught from five longline stations. The former species showed a size range of 494 to 1,573 mm. in standard length and weight from less than 1 kg. to 13·6 kg. The latter

species caught at Stations 304, 305, 307, 313 and 315 measured 504 to 767 mm. in standard length and weighed less than 1 kg. each.

While *A. ferox* was found to be fairly widespread both north and south of the equator up to 34° S. latitude, the distribution of *A. brevirostris* was found to be restricted to between 24° 16′ S. and 35° 34′ S. latitude (along 55° E. and 75° E. longitudes).

Since this is the first time that *A. brevirostris* is being recorded from the Indian Ocean, the frequency of fin ray counts of the species as well as the salient characters by which the two species may be distinguished are given in Tables I and II based on the data collected by me on fresh specimens.

TABLE I

Frequency of fin ray counts

Species	37	38	39	40	41	42	43	44	45	46	47	48	49	No. of specimens
A. ferox	3	7	15	22	18	13	6	7	2	..	1	1	..	95
A. brevirostris	..	..	..	..	1	1	..	2	..	..	..	1	1	6

Species	Pectoral rays 13	14	15	16	No. of specimens	Pelvic rays 7	8	9	10	No. of specimens	Anal rays 14	15	16	17	18	No. of specimens
A. ferox	2	66	24	4	96	1	55	30	—	87	—	16	45	30	3	94
A. brevirostris	5	1	..	··	6	..	··	6	..	6	1	2	3	..	..	6

Examination of gonads of specimens of both species when caught showed that they were all females in different stages of maturity. This is not surprising as on the basis of histological examination, Gibbs (1960) has shown that both species evince hermaphroditism as both male and female gonadial structures are present, the testes lying dorsal to the much larger ovaries in the groove between them.

Now that the identity of the second species of *Alepisaurus*, namely *A. brevirostris*, is well established, it will not be surprising if this species is also identified from the collections from the Pacific Ocean.

TABLE II

Salient characters of A. ferox and A. brevirostris from the Indian Ocean

Characters		*A. ferox* Low (Fig 1 B)	*A. brevirostris* Gibbs (Fig. 1 A)
1. Snout	..	Long, pointed, 7·69 to 8·52% of standard length	Short, bluntly rounded, 4·18 to 5·09% of standard length
2. Head	..	Head long, 17·53 to 20·24% of standard length	Head short, 14·50 to 15·25% of standard length
3. Eye	..	Relatively smaller, being 10·34 to 20·00% percent of head length and 29·92 to 52·63% of snout length	Relatively large, being 17·54 to 23·53% of head length and 56·75 to 75·00% of snout length
4. Pectoral fin	..	Generally 14 to 15 rays and exceptionally 13 or 16 rays	Generally 13 rays and exceptionally 14 rays
5. Dorsal fin	..	Origin above level of posterior margin of operculum; first few anterior rays of fin elongate and free from membrane rest of fin more or less of even height up to a point half-way between P_2 and Λ, after which the rays become abruptly black shorter in a graded series. Fin membrane without any white spots	Origin much anterior to posterior margin of operculum; first few rays of dorsal not elongate but fin gradually arcuate and fin membrane with conspicuous irregular horizontal rows of white spots
6. Body colouration	..	Body colour light with small melanophores; exceptionally a few ocellated melanophores may be seen	Body colour dusky to dark with large melanophores, most of which are ocellated
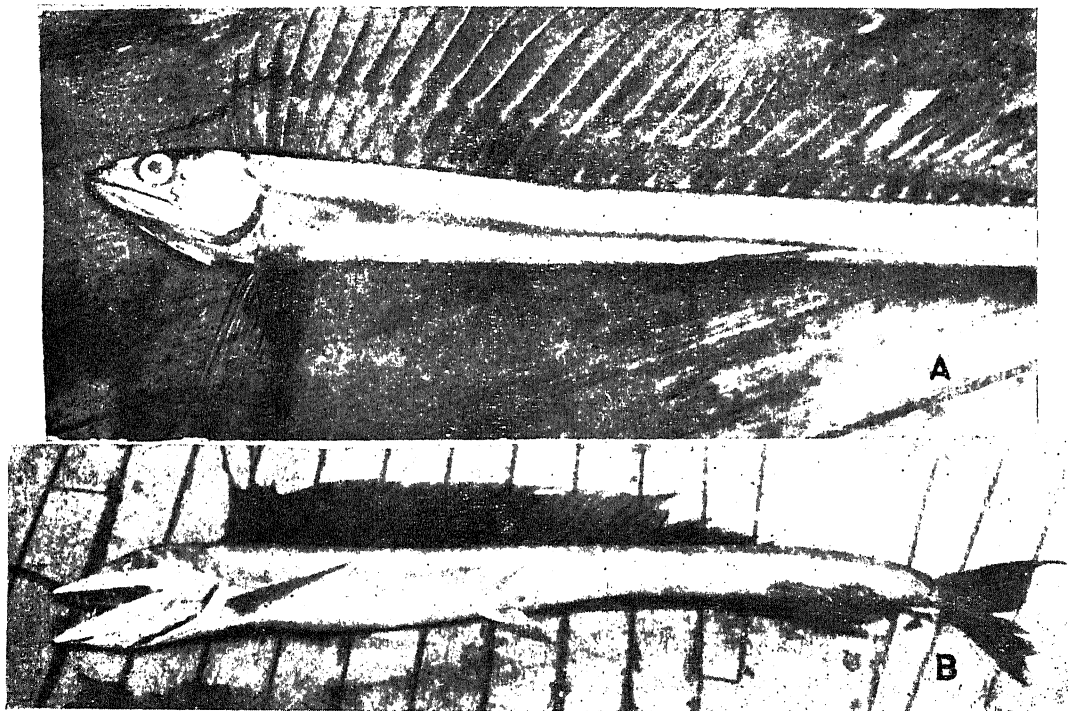
FIG. 1. Lancet fishes (Genus *Alepisaurus* Lowe) from the Indian Ocean. A. *A. brevirostris* Gibbs, 740 mm. in S.L.; B. *A. ferox* Lowe, 1211 mm. in S.L. (Photos by E. G. Silas).

Central Marine Fisheries   E. G. SILAS.
Research Institute,
  (Ernakulam Substation),
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CHANGES IN VOLUME OF A PRAWN MOULTING IN HYPOTONIC SEA-WATER

MOULTING *Carcinus* takes in water equal to its body weight.[6] Drach[3] found that *Cancer* increases its blood volume ninefold while maintaining the same osmotic pressure and that the body fluid pressure increases in *Maja*. It is admitted[1] that the increase of body volume is through intake of water. In all the cases studied so far the increase or decrease of water has been determined by weighing the animals after towelling them to remove as much of the adherent water as possible. This precludes their being weighed frequently and accurately. In the present study the weight in air was calculated[5] from their apparent weights in sea-water of different densities. Hence it was possible to follow the changes in weight every 15 minutes precisely to half a milligram. Further it has been assumed by several that the intake of water during stage E of the molt cycle is through the increase in the proteins, lipids and salts of the blood, though the concentrations of these do not explain the persistence of the body fluid pressure in the next stage, stage A of the moltcycle.

While studying the changes in volume and internal fluid pressure of the estuarine prawn, *Metapenœus monoceros* Fab., when it is transferred to sea-water of different salinities, the author found that the increases and decreases in volume were marked and rapid and were probably caused by water being taken into and out of the gut. But of nearly 40 prawns so studied, one (B) happened to molt. The changes in volume, weight and density of this prawn are presented here. In order to distinguish features belonging to the ecdysial phenomenon from those related to osmotic behaviour, the changes in volume, weight and density of a prawn (A) in the intermolt stage, studied the same day, are given.

Both prawns A and B were from a lot, acclimatised to sea-water of $37\cdot5\%_{00}$ salinity. On transfer to dilute sea-water of $6\%_{00}$ their changes in volume, weight and density were as noted in Table I and illustrated by Fig. 1. B molted overnight and the last three readings were taken from the newly molted prawn. Both were dead on the third morning.

Whereas during the first hour, prawn A increases in volume by $71\cdot5\%$ owing to osmotic entry of water, prawn B increases by only $3\cdot8\%$. This is perhaps because the higher internal fluid pressure of prawn B (whose low density suggests that it has already taken in a large amount of water on its entry into stage E of the molt cycle) would to some degree offset

TABLE I

Time	A				B			
	Density	Weight	Volume	Changed volume (Initial vol. =100)	Density	Weight	Volume	Changed volume (Initial vol. =100)
Initial ..	1·0996	0·1666	0·1515	(100)	1·0459	0·5595	0·5349	(100)
1 hour ..	1·0643	0·2765	0·2597	171·5	1·0460	0·5811	0·5555	103·8
2 hours ..	1·0791	0·1868	0·1731	114·3	1·0436	0·6012	0·5761	107·7
22 do. ..	1·0555	0·2944	0·2789	184·1	1·0326	0·4462	0·4321	80·8
23 do. ..	1·0768	0·1848	0·1716	113·3	1·0322	0·5947	0·5761	107·7
24 do. ..	1·0710	0·1838	0·1716	113·3	1·0337	0·4467	0·4321	80·8
25 do. ..	1·0979	0·1413	0·1287	85·0				

·osmotic pressure. An hour later prawn A regulates its volume by reducing it from 171·5% to 114·3%, whereas B registers a further slight increase. This continued intake of water must be a feature of the molt cycle. Next morning (20 hours later) A had a volume of 184·1% which it reduced to 113% and to 85% of the initial, after nearly 25 hours after its transference to dilute sea-water. B, however, was

TIME AFTER TRANSFERENCE TO SEA WATER OF 6%.
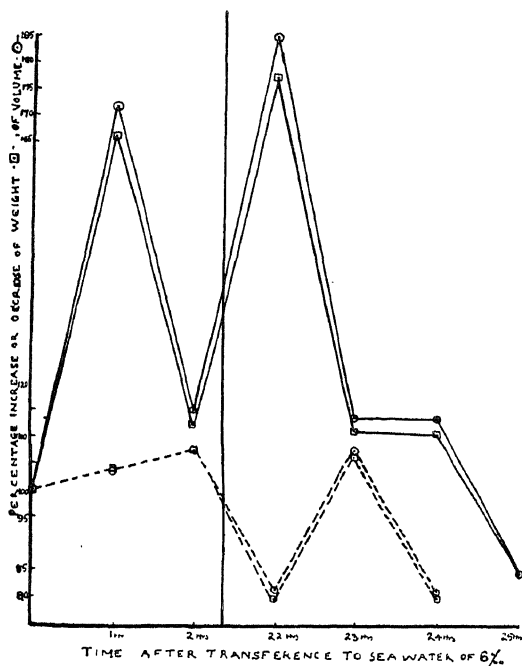
FIG. 1

found 22 hours after its transference to dilute sea-water, in the final stages of emergence from the cuticle. Its volume had shrunk to 81% of its initial volume. Since the exuvium had a volume of 0·097 c.c., nearly 0·047 c.c. of water should have left the body to account for an overall reduction of 0·1440 c.c. During the next hour the volume increases to 107·7%, but falls back to 80·8% in the hour after. Such rapid gains and losses of water in both A and B suggest the operation of a mechanical factor, rather than a physiological process of diffusion of water into and out of tissues. It is probable that the gut which can take in and evacuate water[2,4] may be responsible for these marked changes in volume and pressure of not only the prawns under osmotic stress, but also the prawns in stage E of the molt cycle.

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A STUDY OF THE MEIOTIC CHROMOSOMES OF THE SCORPION *BUTHUS TAMULUS* FABR.

The scorpion *Buthus tamulus* Fabr. is widely distributed in India, particularly in West Bengal. Cytological studies of *B. martensii* and *B. eupeus* have been made by Sato (1936)[1] and Sokolow (1913)[2] respectively; but very little is known about the chromosomes of *B. tamulus*. Knowledge on the chromosomes of this Indian scorpion seems to be useful and some preliminary observations are recorded here.

Several males were collected from the western suburbs of Calcutta. The testes were dissected in normal saline solution and fixed in Carnoy's fixative for sectioning; sections were cut at 10 micron thickness and stained with Heidenhain's hæmatoxylin. For squash preparations the testes were fixed in Aceto-alcohol and stained with Aceto-carmine. The squash preparations gave better results. The figures were drawn with the aid of a Spencer's Camera lucida.

Spermatogonial metaphase of *Buthus tamulus* (Fig. 1, *a*) shows 24 thick chromosomes more or

(b)   **(a)**
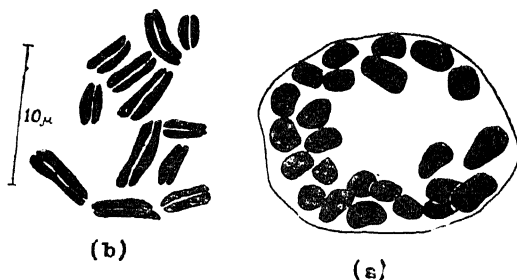
FIG. 1. *Buthus tamulus* Fabr. (*a*) Spermatogonial metaphase showing 24 chromosomes. (*b*) Metaphase I. with 12 bivalents.

less uniformly distributed along the periphery of the nucleus. The leptotene network is distinct. The zygotene chromosomes are long and slender, and with the progress of meiosis

they became thick and short. Twelve distinct bivalents (Fig. 1, b) are observed in the metaphase I. They are either in proper equatorial arrangement or distributed throughout the nucleus. They are straight and without any constriction or bending. This suggests the polycentric or diffused centromeric activity of the chromosomes of *Buthus tamulus* similar to those of the Brazilian scorpions *Tityus* sp. and *Isometrus* sp. (White, 1954).[3]

The most characteristic feature of these chromosomes is the absence of any chiasmata. The homologs are seen to remain side by side. (Fig. 1, b). During anaphase the homologs move away towards the pole lying parallel to the equatorial region or in some cases by a slight raising of one end of the chromosome towards the pole. Towards late anaphase one end of all the chromosomes is found to enter a common knot. The above facts lend support to Piza's[4] interpretation that probably a centromere is there at or near the end of the chromosomes.

No structural rearrangement or translocation as observed by Piza[5] in *Tityus bahiensis* and *Isometrus maculatus* was found here. And hence White's[3] explanation that those sexually reproducing animals without any crossing over would manage to establish themselves by many types of translocation does not hold good here. Therefore the question still remains as to how recombinations in these animals take place.

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Cytogenetics Lab.,   Ashish Kr. Dutta Gupta.
Dept. of Zoology,   Sanat Kr. Sarker.
University of Calcutta,
35, Ballygunj Circular Road,
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X-RAY INDUCED MUTATIONS IN CULTIVATED RICE, N.P. 130

DRY, dormant seeds of the cultivated rice variety N.P. 130 were irradiated with X-rays at four doses, 11, 22, 33 and 44 Kr. Data on germination, height of M_1 plants, cytological abnormalities and chlorophyll mutations secured in the progenies of the treated material were reported by Shastry and Ramaiah (1961). Viable mutations secured in M_2–M_4 generations of this material along with their inheritance will be discussed here.

(*i*) *Dwarfs.*—These are the most frequent of all the viable mutations and are secured in 4 different M_1 plant progenies, out of 99 tested. While normal plants of N.P. 130 are 150–160 cm. tall, dwarfs of different grades are 50–110 cm. tall. The shortest dwarf noticed in the culture 4-2-4 has narrow leaves. Most commonly, dwarfs are about 90-100 cm. tall as in the cultures 5-2-4 and 13-11-1. These exhibit broad dark green leaves which are brittle in comparison to normal. The panicles in the dwarf are compact and the grain size comparable to normal plants. All dwarfs observed are controlled by a single recessive gene as evident from 3 : 1 ratio in M_3 and M_4 generations, although in M_2 the frequency of mutants was less. These mutants are comparable to erectoides rices of Li, Hu, Chang and Weng (1961), short-culmed mutations of Kawai, Sato and Masima (1961) and stiff strawed mutants of Benkendam (1961) reported in rice.

(*ii*) *Rolled leaf.*—This mutation was secured in a single M_1 plant progeny 13-11 and in this its occurrence coincides with that of dwarf mutation. The lamina is dark green and is rolled over a prominent "midrib". Rolled leaf plants exhibit a wide array of phenotypic abnormalities in ligule, tubercular prominence on lamina, swelling of middle veins in lamina, gaping spikelets, high sterility (90-99% in spikelets), sponginess in panicle, palear awning, fasciation of peduncle, etc. Rolled leaf (*rl*; Chang and Jodon, 1963) is controlled by a single recessive gene as is evident from 3 : 1 segregation tested in several M_3–M_4 progenies. Bekendam (1961) reported rolled leaf mutation in rice following X-radiation, but it is not known whether he observed the collateral character complex.

(*iii*) *Shy tillering.*—In some M_3–M_4 progenies tracing to two different M_1 plants, shy tillering mutant was recorded. These mutants exhibit a solitary tiller which flowers and sets seed

normally. This character is also controlled by a single recessive gene.

Dwarf and rolled leaf loci are independent in segregation. Since these mutants occur in one and the same M_1 plant progeny, double mutant for these characters was isolated. Morphology of the different mutants is presented in Table I.

TABLE I

Mutants	Culture Nos.	Characters			
		Ht. cm.	Tiller No.	Length of the panicle (cm)	Fertility %
Dwarf	5- 2-4-2-30	99·0	6	21	80
	13-11-1-7-33	106·0	2	19	78
Rolled leaf	13-11-1-1-76	121·0	4	13	9
	13-11-1-10-27	100·0	4	15	4
Dwarf rolled leaf	13-11-1-10-77	100·0	2	18	43
	13-11-1-4-73	91·0	3	17	49
Shy tillering	14-12-2-1-17	103·0	1	19	82
Normal N.P. 130 (control)		150·0	12	29	92

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OCCURRENCE OF *MACROPHOMINA PHASEOLI* (MAUBL.) ASHBY ON GARLIC BULBS

Macrophomina phaseoli (Maubl.) Ashby has been reported from different regions of the world occurring on a large number of hosts. In India it has been reported on *Solanum tuberosum* L., *Cajanus cajan* (L.) Millsp., *Carica papaya* L., *Citrullus vulgaris* Schrad, *Cucurbita maxima* Duch. and a variety of other plants as root, stem and tuber parasite. Dastur (1935)[1] observed a disease of *Piper betle* L. (Vern. *Pan*) caused by *Macrophomina phaseoli* in Central Provinces. Recently Singh and Gupta (1954)[2] recorded it as root-rot pathogen of Spinach in Kanpur.

During the year 1962-63 the authors isolated this organism a number of times from Garlic bulbs stored in the local markets. Externally both healthy and diseased bulbs appear to be similar but a careful examination under lens after peeling the outer leaf-scales revealed the presence of large number of black pin-head dots like sclerotia on the inner leaf-scales. The sclerotia which show some differentiation between cortex and medulla are smooth, black and hard. Examination of the fully diseased bulbs showed that as a result of fungal infection the edible yellowish fleshy portion of the leaf-scales is reduced to a hard, brown mass without the usual smell of garlic.

The fungus grows well on Asthana and Hawker's medium 'A' and potato dextrose-agar medium at 25° C ($\pm$ 2° C.) and shows the following morphological characters :

Pycnidia dark, sunken, globose with minute ostiole ; 123–132 μ diameter conidiophores simple, conidia hyaline, cylindrical, with rounded ends, one-celled, $22-32 \times 8-10 \mu$.

Pathogenicity experiments were carried out with pure culture of the fungus by soil inoculation technique. Healthy bulbs were sown in pots containing inoculated sand. Typical symptoms appeared after 20 days. The bulbs in controlled pots remained healthy. Cross-inoculation studies indicated inability of the fungus to infect bulbs of *Allium cepa* L. Both the varieties of onion were found to be **non-susceptible** to the disease.

In as early as 1943 Altstatt and Smith[3] reported a bulb-rot of Garlic (*Allium sativum* L.) from Texas caused by *Sclerotium bataticola* Taub. (*Macrophomina phaseoli*). Since then no second record of this disease has been made from any part of the world.

The authors wish to express their grateful thanks to Dr. J. C. F. Hopkins for his help in the identification of the organism.

Plant Pathological Laboratory, SUDHIR CHANDRA.
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University of Allahabad,
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AN INSTANCE OF ABNORMAL MEGASPOROGENESIS IN *PEPEROMIA*

THE embryo-sac of *Peperomia* is tetrasporic and hence, the divisions of its megaspore nucleus are not accompanied by wall formation until the sixteen-nucleate stage is reached. However, transitory cell plates, which do not form an actual cell-wall and disappear later, have been reported to occur in certain instances in some of its species (Brown, 1908; Fisher, 1914; Johnson, 1914; Able, 1924; Fagerlind, 1939; Murty, 1959).

In a set of slides of *Peperomia* sp. examined, an abnormal case of megasporogenesis was observed. The megaspore, in this case, is completely divided into three clear-cut cells; of these, the one at the chalazal end is larger than the other two (Fig. 1). From the nature of the cells there is good reason to assume that this condition should have come about by the formation of two separate cells after the first division of the megaspore nucleus, followed by division of the nucleus of the micropylar cell likewise accompanied by complete separation into two cells. The nucleus of the larger, chalazal cell is at an advanced prophase stage while the other two cells have well-organised nuclei. Thus, the second division is not synchronous in the two dyad cells.

In the other ovules of the same spike, a typical tetrasporic type of development was observed. Absence of formation of two cells after the first division, a perfect synchronization of the second division, during the telophase of which, evanescent cell plates are laid (Fig. 2), and the characteristic cruciate arrangement of the four nuclei in the coenomegaspore (Fig. 3), are all clearly seen.

Whether the abnormal instance noted here will follow a tetrasporic development by the dissolution and the separation of cells after the formation of four nuclei, as reported in certain other instances of tetrasporic development (Bergman, 1935), or whether it may follow a bisporic or monosporic development, cannot be said with certainty.
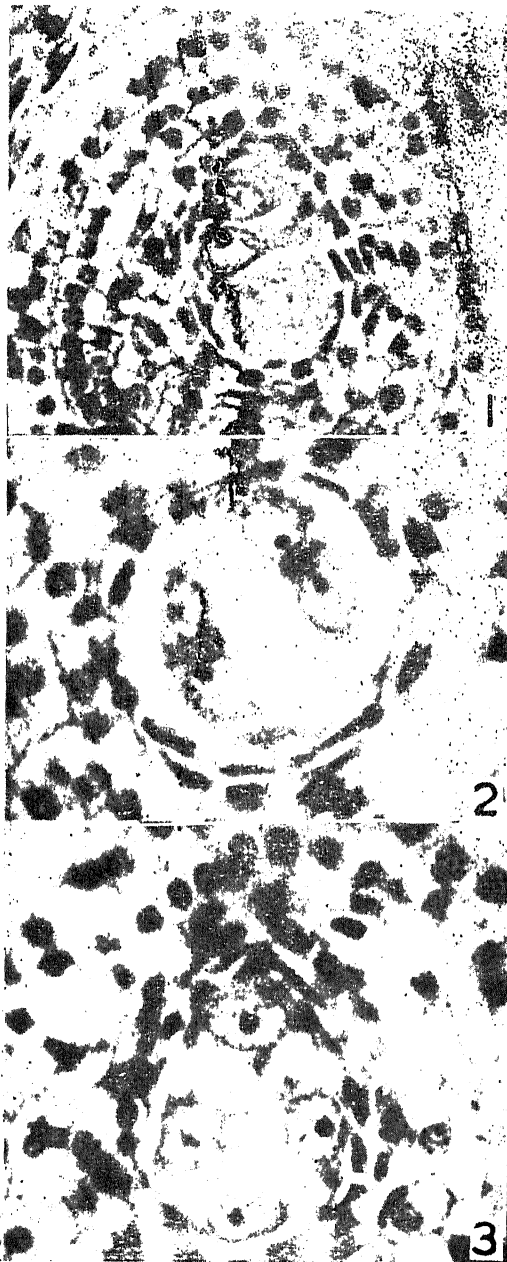
FIGS. 1–3. *Peperomia* sp. Fig. 1. Divided, abnormal megaspore, × 543. Fig. 2. Telophase of the second division of normal megasporogenesis, × 920. Fig. 3. Cruciate arrangement of the four nuclei in normal coenomegaspore, × 955.

Department of Botany,   K. PERIASAMY.
Presidency College,
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A RADIATION-INDUCED USEFUL MUTANT OF ANNUAL CHRYSANTHEMUM

THE effectiveness of various types of mutagens in inducing morpho-genetic variation in floral characteristics and the utilization of induced mutants in developing improved strains of ornamental plants has been reported by several investigators.[1-3] During the course of a mutation breeding programme, striking changes affecting the flower form were observed in M_2 population of a "single" type Chelsea variety of *Chrysanthemum carinatum* when dry seeds were subjected to an X-ray dose of 15 Kr. The mutant types included a change from "single" type flower-heads into "double" type and conversion of "open" type ray florets into tubulars. Of particular interest was a mutant having bisexual ray florets instead of the usual pistillate type (Fig. 1). Breeding analysis showed that

FIG. 1. Pistillate ray floret of the control type (*c*) and bisexual ray florets of the matant type (*m*).

this mutant condition was determined by a recessive gene. Both the pollen and the seed fertility of the bisexual ray florets were normal.

In the "single" flowered chrysanthemums, the florets comprising the flower-head are of two kinds : the bisexual disc florets that form the centre are surrounded by one whorl of the pistillate ray florets that form the display or "petals". In a perfect "double" flower, the bisexual disc florets are almost completely replaced by pistillate ray florets ; although at times a "double" flower grows imperfectly and produces some disc florets in the centre. Thus, a "double" flowered strain has to depend entirely, or nearly so, upon "single" types for pollination. Hybrid seed thus obtained segregates for "doubleness" and, hence, we do not have a true breeding "perfect double" strain. It is in this context that the mutant with bisexual ray florets assumes significance. It is now proposed to incorporate the mutant condition into "double" strains which at present have to be crossed with "semi-double" pollen parents for their maintenance.

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Division of Botany,   R. S. RANA.
Indian Agric. Res. Inst.,
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CYTOLOGICAL EFFECTS OF HYDROXYLAMINE AND 5-AMINO-URACIL ON SALIVARY GLAND CHROMOSOMES OF *DROSOPHILA MELANOGASTER*

MANY of the chemicals, like hydroxylamine (HA), which affect the nitrogenous bases of the DNA molecule, or like 5-aminouracil (5-AU) which inhibit the DNA synthesis, have been shown to be mutagenic in bacteriophages, bacteria, and to induce chromosome breakage in higher organisms.[1,2] In the present report, the effects of these two chemicals on the salivary gland chromosomes of Drosophila are described. These chromosomes are ideal for such a study since their multi-stranded nature and constant prophase condition provide a good opportunity for detecting cytological changes induced in them.

Hydroxylamine (NH_2OH) was used as 0·2% solution at pH 7 (10 mg. HA + 10 mg. NaCl in 5 ml. of distilled water) with high salt concentration. 5-Aminouracil was used as 0·1% solution (25 mg. in 25 ml. of water). They were separately mixed with the basic medium comprising of agar (3%), yeast (10%), glucose (10%), propionic acid (0·4%) and water (100 ml.). Freshly laid Drosophila eggs (of Oregon-K) were transferred into this medium and the larvæ were allowed to feed up to the 3rd instar stage. The salivary glands were dissected out in saline water and squashes were made in aceto-orcein.

The type and frequencies of different aberrations scored are given in Table I. The characteristic type of breaks induced by hydroxylamine was associated with the chromocenter, i.e., the heterochromatic region, where all the chromosomes are fused together by their centromere. In some instances individual chromosomes were

TABLE I

Treatment	No. of cells scored	No. of cells affected	Cells with centric break	Inversions	Loops
Control ..	94	1	..	..	1
HA ..	80	14	9	..	5
5 AU ..	85	18	..	10	8

found to lie away from the rest of the chromosomes (Fig. 1), or single arms were lying aloof, indicating breakage at the centromere. The centric breakage, following the treatment with HA at pH 7, has been reported in mammalian chromosomes[3] and in plant chromosomes,[4] and this has been interpreted by these authors as due to the richness in GC base of pairs in the centromeric DNA, and to the specific effect of HA given under these conditions on cytosine. The present observations lend support to the earlier findings made in other organisms, with regard to the effect of HA on centromere.
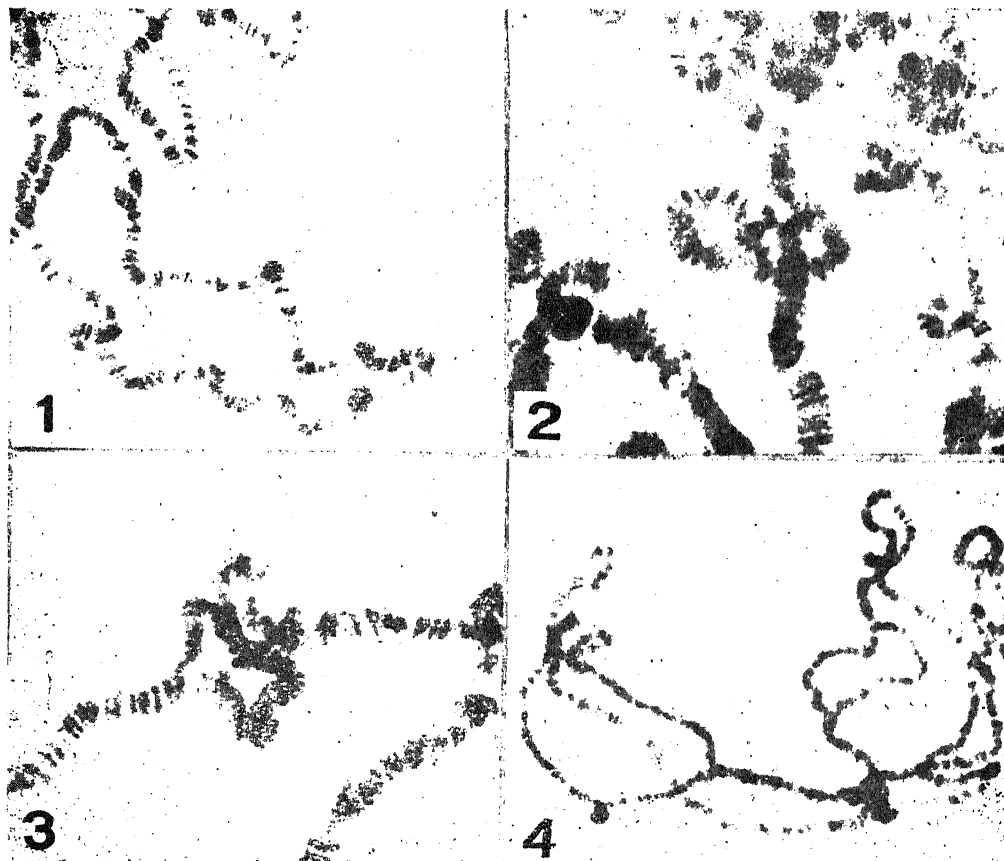
FIGS. 1-4. Fig. 1. Dissociation of whole chromosome from the chromocenter, following treatment with HA at pH 7·0, × 405. Fig. 2. Simple inversion loop induced by 5 AU, × 1,100. Fig. 3. Complex inversion loop induced by 5 AU, × 1,300. Fig. 4. Unpaired loops, induced by HA at pH 7·0, × 120.

Ten cells, showing inversions, were observed in 5 AU treated material, ranging from very simple inversions (Fig. 2) to complex ones (Fig. 3). These inversions can be explained only on the basis of breakage and reunion, following 5 AU treatment. 5 AU is known to inhibit DNA synthesis by interfering with thymine synthesis, folic acid metabolism[5] and is also known to induce chromosome breakage in higher plants.[6] The other type of aberrations, caused by both HA and 5 AU, was the unpaired loops present in the chromosomes (Fig. 4), and this non-pairing, appears to be due to change in surface properties of the two chromosomes, since the banding patterns were the same in this region, indicating that no inversions were involved. Mutation experiments with HA and 5 AU are in progress in Drosophila and the results will be reported elsewhere.

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September 5, 1964.

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PRATHIGADA ZIZYPHI SP. NOV.

THE fungus which forms the subject of this note was collected on living leaves of *Zizyphus nummularia* Vahl. at the Agricultural College campus, Coimbatore. It formed dark greenish-brown, velvety colonies on the underside of the leaf, about 4 mm. in diameter, roughly circular or angular in outline and sometimes coalescing. Yellowish spots were seen on the upper surface of the leaf corresponding to the colonies. A cross-section of the leaf through the fungus colony showed that the mycelium of the fungus was internal, septate, branched and pale brown in colour. Conidiophores emerged in groups through the stomata. After emerging these were somewhat divergent, bent, sparsely branched towards the base, septate and deep yellowish-brown in colour. These conidiophores bore conidia acrogenously and singly. Conidia were obclavate, 2-5 septate, with a narrowed apex and truncate base and uniformly pale brown in colour. The conidia measured $28-56 \times 7-12 \cdot 6 \mu$.

The fungus closely resembled the Dematiaceous genus *Prathigada* Subram. (Subramanian and Ramakrishnan, 1956[1]). *Prathigada* was proposed as a *nom. nov.* for *Macroea* Subramanian described earlier (Subramanian, 1952[2]). Two species of *Prathigada*, *P. cratoevoe* (Syd.) Subram. and *P. punjabensis* (Subram.) Subram.,
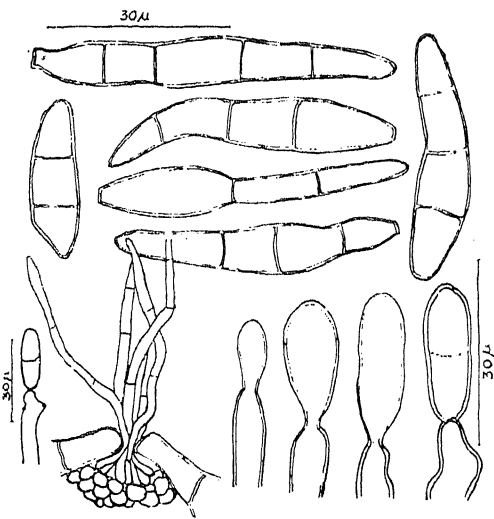
FIG. 1. *Prathigada zizyphi*: Conidia and conidiophores.

are known, both being on living leaves of *Cratoeva religiosa*. The present fungus, besides being on an entirely unrelated host, also differs in conidial characters from these two species. The conidia are broader and longer in the present species and the conidiophores are also septate. A new species *P. zizyphi* is, therefore, proposed to accommodate the present fungus.

Prathigada zizyphi SP. NOV.

Hypophylla; coloniae circulares, irregulares vel coalescentes usque 4 mm. diam., brunneolae, velutinae; conidiophori erecti vel curvati, recti vel tortuosi, ramosi, pallide brunneo, dense aggregati; conidia acrogena, singula, apici cuiusque conidiophori insidentia, haud catenulata, obclavata, 2-5-ut plurimum septata, cellulae pallide brunneae colorae, apice attenuato sed obtuso, basi truncati, $28-56 \times 7-12 \cdot 6 \mu$.

Habitat: supra folia *Zizyphus nummularia* Vahl., Agricultural College, Coimbatore, India, 23-iv-1962 (typus), leg. A. Venkata Rao (Herb. Plant Pathology, Agricultural College, Coimbatore, No. 187),

Plant Pathology Section,   A. Venkata Rao.
Agric. College and Res. Inst.,   K. Ramakrishnan.
Coimbatore-3, *September* 19, 1963.

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STUDY OF RIBONUCLEASE (RNA-ase) ACTIVITY UNDER ZINC, PHOSPHORUS AND COMBINED ZINC AND PHOSPHORUS DEFICIENCIES IN CITRUS SEEDLINGS

It is now known that zinc is an essential constituent of a number of enzyme systems and when its supply falls short of physiological requirement of green plants, serious metabolic disturbances are noticed. Kessler and Monselise[3] have suggested that increased ribonuclease activity in zinc-deficient citrus leaves is responsible for impaired synthesis of ribonucleic acid (RNA) and proteins. These investigations were carried out on plants showing symptoms of chlorosis, mottling and reduction in leaf size. In view of the above, an investigation was undertaken to study the ribonuclease activity under combined deficiency of zinc and phosphorus where the typical symptoms of mottling were absent and the reduction in the leaf size (little leaf) was the only characteristic feature.

Seedlings of mandarin orange (*C. reticulata* Blanco) were raised in Hoagland's[2] solution following the technique described earlier[5]. The salts providing the major nutrients for zinc-deficient cultures were purified following the procedure detailed by Hewitt[1]. Control having the normal supply of the culture solution were simultaneously maintained for relevant comparison. The enzyme activity adopting the method followed by Kessler and Monselise[3] was measured at the incipient stage of the starting of the symptoms and advanced stage when the symptoms were very much prominent in the leaves.

The zinc-deficient cultures showed typical symptoms such as reduced size of the leaves, interveinal mottling with dark green midrib. Chlorosis generally appeared on the margins of the leaves and these patches advanced towards the midrib. Phosphorus-deficient cultures showed a dull bluish-green foliage. Under combined deficiencies of zinc and phosphorus, reduc-tion in leaf size and slightly dull green colour of the leaves were the only noticeable symptoms.

TABLE I

Ribonuclease activity under different treatments

(RNA-ase activity as % hydrolysis of RNA)

Treatment	% RNA-ase activity 27-1-1963 (Incipient stage)	% RNA-ase activity 10-4-1963 (Advanced stage)
Control	24·00	28·35
− Zn	28·00	31·00
− P*	17·00	25·65
− Zn − P*	19·00	27·00

*P : Phosphorus was maintained at 4 p.p.m. in the deficient culture.

Under zinc deficiency it is seen that RNA-ase activity was increased which appeared to be in conformity with the results of Kessler and Monselise[3] but under combined deficiency there was rather a decrease in the activity. As these cultures did not show the symptoms of mottling, it is plausible that there might be lesser impairment of the chloroplastic proteins due to above decrease in RNA-ase activity. The cultures under phosphorus deficiency comparatively developed a blocking effect on the enzyme activity.

Further, it is interesting to observe that ribonuclease activity increases as the plant gets older. The results obtained by Naik and Asana[4] are more or less in conformity with the present findings, however, these results related to the study of RNA-ase activity in the mature and young cotton leaves.

The author is indebted to Dr. M. S. Swaminathan for the facilities and the interest in the progress of investigation and Prof. R. D. Asana for his valuable suggestions.

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REVIEWS

Biochemical Disorders in Human Diseases. By R. H. S. Thompson and E. J. King. (Academic Press, Inc., 111 Fifth Avenue, New York-3), 1964. Pp. 1066. Price $ 22.00.

Seven years have elapsed since the first edition of this book was prepared. The advances that have taken place in our knowledge of the biochemical changes underlying, or associated with, many diseases have been striking. Quite naturally, therefore, substantial revisions have been called for so as to give an outline of what is being achieved in this field. It was also thought desirable to introduce four new chapters to this edition.

The book consists of twenty-four chapters : the subjects dealt with and their respective authors are listed below: I. The Chemical Anatomy of the Human Body by R. Passmore and M. H. Draper ; II. Nutritional Disorders by R. Passmore and M. H. Draper ; III. Diseases of the Gastro-Intestinal Tract by D. A. K. Black ; IV. The Pancreas by Henry T. Howat ; V. Diseases of the Liver and Biliary Tract by Noel F. Maclagan ; VI. The Anæmias by Sheila T. Callender and J. R. P. O'brien ; VII. Diseases of the Blood, The Clotting Mechanism by R. G. Macfarlane ; VIII. Atherosclerosis by G. S. Boyd ; IX. Hypertension by G. W. Pickering and W. S. Peart ; X. Diseases of the Kidney and Genito-Urinary Tract by M. D. Milne ; XI. Diseases of the Adrenal Glands by Donald Longson and Nicholas P. Christy ; XII. Disorders of Iodine Metabolism by J. Wolff ; XIII. Diseases of Bone and the Parathyroid Gland by Russell Fraser and E. J. King ; XIV. Diseases of the Nervous System by R. H. S. Thompson and J. N. Cumings ; XV. Diseases of Muscle by Kenneth Zierler ; XVI. Diabetes Mellitus and Hypoglycæmia by Peter H. Forsham and Gerold M. Grodsky ; XVII. Protein Anomalies of the Lymphoreticular System by N. H. Martin ; Chapters XVIII to XXIII. Miscellaneous Disorders of Metabolism : I : Some Abnormalities of Amino-Acid and Hæmoglobin Metabolism by H. Harris and M. D. Milne ; II : Connective Tissue Disorders by E. G. L. Bywaters and L. E. Glynn ; III : Porphyrias by C. H. Gray ; IV : Idiopathic Hæmochromatosis and Related Iron Storage Diseases by T. H. Bothwell and C. A. Finch ; V : Glycogen Storage Diseases and Galactosæmia by Dorothy H. Andersen ; VI :

Lipidoses by N. Zöllner and S. J. Thannhauser ; XXIV : Disorders of the Reproductive Organs by P. M. F. Bishop and I. F. Sommerville.

It will be evident that the volume will be an indispensable addition to any medical or bio-chemical library.   C. V. P.

Italian Physical Society—Proceedings of the International School of Physics held at Varenna, Italy. (Published by the Academic Press, Inc., 111, Fifth Avenue, New York-3).
Course 29: *Dispersion Relations and Their Connection with Casualty*, 1964. Pp. xvi + 256. Price $ 12.00.

The course was held from the 15th July to the 3rd August, 1963. It was directed by Eugene P. Wigner by whom also the volume has been edited. It was attended by fifty-three persons. The introductory pages are devoted to a lecture by Professor E. P. Wigner on "The Role of Invariance Principles in Natural Philosophy". The rest of the volume consists of the under-mentioned six memoirs by their respective authors : I. The Proof of Dispersion Relations by M. Froissart ; II. Casualty, R-Matrix, and Collision Matrix by E. P. Wigner ; III. Dispersion Relations and Applications by D. Y. Wong ; IV. The Non-Relativistic Angular-Momentum Plane by R. G. Newton ; V. Production Amplitudes by P. V. Landshoff and VI. High-Energy Scattering and Dispersion Theory by R. Oehme.

The memoirs are mathematical and deal with the problems arising in Nuclear Physics, especially the creation of particles, scattering problems and the like.   C. V. R.

Dover Reprints in Aeronautics :

Theory of Flight. By Richard Von Mises. (Dover Publication, Inc., New York.) Pp. xvi + 629. Price two dollars and eighty-five cents.

Theory of Wing Sections. By Ira H. Abbott and Albert E. Von Doenhoff. (Dover Publications, Inc., New York.) Pp. 1 to 693. Price two dollars and ninety-five cents.

Weight-Strength Analysis of Aircraft Structures. By F. R. Shanley. (Dover Publications, Inc., New York). Pp. 1 to 404. Price two dollars and forty-five cents.

The first of these books is an unabridged reprinting of the 1945 edition of Von Mises's

treatise which is almost unsurpassed as a balanced and well-written account of fluid dynamics, though it is limited to situations in which air compressibility is unimportant.

The second of these books is by authors whose positions in the National Aeronautics and Space Administration are a sufficient indication of its authoritative nature. Its first half is of a theoretical nature, while the second half is devoted to tables and graphs setting out airfoil data.

The third book is an unabridged reprinting of the 1952 edition of the book by the author who is Professor of Engineering at the University of California. The book is intended to meet the need for scientifically sound methods of analysing and predicting the structural weight of aircraft and missiles. The subject has, of course, gained enormously in interest with the more recent developments in the aircraft industry. C. V. R.

Mammalian Protein Metabolism, Volume I. Edited by H. N. Munro and J. B. Allison. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. 566. Price $ 18.50.

The treatise, of which the first volume is under review, is to consist of twenty-three chapters in two volumes. It brings together the contributions of the biochemist, the nutritionist, and the medical research worker to give a modern picture of the normal and pathological aspects of protein metabolism in mammals, notably in man. Although written as a multi-author text, the book is designed to be read in continuity by those who have only a general knowledge of the outlines of protein metabolism, as presented in text-books of general biochemistry. In order to emphasize this continuity, each part of the three parts of the treatise is introduced by a short general survey of the area covered. The volume under review deals with the biochemical mechanisms, while the second volume will deal with the nutritional and pathological aspects of protein metabolism.

The first chapter of Volume I is a very interesting historical account of the development of our present concepts of protein metabolism. The other chapters and their respective authors are listed below : Protein Digestion and Absorption in Non-Ruminants by Carlos Gitler ; The Digestion and Absorption of Nitrogenous Compounds in the Ruminant by A. T. Phillipson ; Free Amino-Acids and Peptides in Tissues by Halvor N. Christensen ; The Metabolic Fate of Amino-Acids by H. A. Krebs ; The Mechanism

of Protein Synthesis by A. Korner ; Studies on Turnover in the Whole Animal by A. Neuberger and F. F. Richards ; Metabolism of Plasma Proteins by A. S. McFarlane ; Some Aspects of Hormone and Protein Metabolic Interrelationships by James H. Leathem ; General Aspects of the Regulation of Protein Metabolism by Diet and Hormones by H. N. Munro ; Elimination of Nitrogen from the Body by James B. Allison and John W. C. Bird.

The treatise will serve admirably as a source-book for the graduate student and will also interest the specialist who needs an authoritative account of selected areas in the subject.

C. V. R.

Advances in Space Science and Technology (Vol. 5). Edited by Frederick I. Ordway (Academic Press, New York and London), 1964. Pp. xvi + 334. Price $ 13.00.

Volume five of the *Advances in Space Science and Technology* consists of six chapters dealing broadly with solar physics, rocket technology and communication relay satellite techniques, geodetic satellites and orbital operations. The first chapter deals with the astronautical investigations of the sun, which challenges with more problems, the more we accumulate facts about it. Space exploration of the sun, the author states, should be used as a means of probing into the new realms of solar physics, both by searching out suspected phenomena that are shielded from ground-based observations by our terrestrial atmosphere and by seeking out new phenomena as a means of broadening the scope of our research efforts in both astrophysics and geophysics. The author gives a fast survey of the recent advances in the solar magnetic fields, the corpuscular emission or the solar wind and suggests several experiments utilising space vehicles, that may be used to attack problems of fundamental research.

Chapter II deals with the progress made in communication relay satellite techniques. Three major types of the communication satellites are (1) relay satellites, (2) broadcast satellites and (3) distribution satellites. A relay satellite is intended to handle bulk messages traffic between two points on the earth's surface and provides a point-to-point service. Broadcast satellites are intended to provide programme service to a large number of listeners scattered over a wide area, while distribution satellites transmit specialised material from its source to a number of distribution points, which 'retail' the signal to the ultimate user. These two types of satellites

service replace thoroughly the present broadcasting and the TV programmes. In this chapter, the authors review the major design factors in satellite systems, providing at the same time information on the actual and proposed system.

The terrestrial as well as the lunar applications of geodetic satellites are treated by three authors in a chapter entitled "Terrestial, lunar and planetary applications of navigation and geodetic satellites". This chapter deals with historical reviews of navigation, geodetic satellites, and the investigation of the gravitational fields of the moon and planets with artificial satellites. The remaining chapters of the book deal with solid propellant rocket technology and environmental control of manned space vehicles.

Phenomenal progress has taken place during the last five years on subjects like the gravitational potential of the earth, the geomagnetic cavity and the Van Allen radiation belts, which are some of the outstanding scientific discoveries made through artificial satellites, but the first five volumes of the series have been devoted mainly to rocket technology, communication systems and propulsion. It is hoped that the editors will pay greater attention to bringing in detailed review articles on these topics in the future volumes. K. S. VISWANATHAN.

Elementary Mathematical Analysis. By Prof. A. E. Labarre, Jr. (Addison-Wesley Pub. Co., Inc., Reading, Massachusetts, U.S.A.), 1961. Pp. xii + 706. Price $ 7.75.

This is a book of introductory college mathematics and is intended to provide a one-year foundation course in science, engineering or mathematical education.

Besides traditional topics of algebra, trigonometry, analytic geometry and elements of the calculus from a modern vantage point, relatively recent concepts such as notions of linear programming problem, vector and linear transformation, etc., from an elementary viewpoint have also been dealt with in this book. Written in a lucid and persuasive style, the book is replete with worked examples. There is an abundance of exercises and review problems throughout the book to cater to students of varying degrees of mathematical training. Particularly these two preceding features should enable the book to be of great appeal to all students who wish to acquire a well-founded mathematical background. M. S. S.

Progress in Nucleic Acid Research. Edited by J. N. Davidson and W. E. Cohn. (Academic Press, Inc., 111, Fifth Avenue, New York), 1963. Vol. 1 : Pp. xiv + 424. Price $ 13.00 ; Vol. 2 : Pp. xiii + 346. Price $ 11.00.

The last volume of the three-volume treatise on 'The Nucleic Acids—Chemistry and Biology', edited by E. Chargaff and J. N. Davidson, appeared in 1960 and since then the progress in the field has been so rapid that the need for an annual review dealing with the latest developments has been keenly felt. Although the present volume is not expected to be an annual publication, it is expected to appear periodically and will contain essays on particular aspects related to the field of nuclear acids.

The scope of the volumes under review is best described by the chapter headings : Vol. I— Primer in DNA Polymerase Reactions, The Biosynthesis of Ribonucleic Acid in Animal Systems, The Role of DNA in RNA Synthesis, Polynucleotide Phosphorylase, Messenger Ribonucleic Acid, The Recent Excitement in the Coding Problem, Some Thoughts on the Double-Stranded Model of Deoxyribonucleic Acid, Denaturation and Renaturation of Deoxyribonucleic Acid, Some Problems Concerning the Macromolecular Structure of Ribonucleic Acids, The Structure of DNA as Determined by X-ray Scattering Techniques, and Molecular Mechanisms of Radiation Effects ; Vol. II—Nucleic Acids and Information Transfer, Nuclear Ribonucleic Acid, Plant Virus Nucleic Acids, The Nuclease of *Escherichia coli,* Specificity of Chemical Mutagenesis, Column Chromatography of Oligonucleotides and Polynucleotides, Mechanism of Action and Application of Azapyrimidines, The Function of the Pyrimidine Base in the Ribonuclease Reaction and Preparation. Fractionation, and Properties of RNA.

All the chapters are ably written by persons who are intimately familiar with the topics which they cover. For instance, the chapter by F. H. C. Crick on the coding problem is highly thought-provoking. He gives strong evidence to show that the code is degenerate. The "weight of evidence certainly suggests that it is a non-overlapping triplet code, heavily degenerate in some semisystematic way, and universal or nearly so". Again the chapter by V. Luzzati on the structure of DNA deals with the structure as it exists in solution, which is not amenable for study by the usual methods of X-ray diffraction, but requires special studies by small-angle scattering. Such studies made, for example, with NaDNA in solution shows that

"over a wide concentration range (1-50%) the molecules are rod-shaped with a mass per unit length in close agreement with the Watson-Crick model, and that the totality (or at least 90%) of the DNA takes up this ordered structure".

Although some of the articles are controversial, the book serves a definite purpose in bringing to the reader the latest developments in a readily accessible form. The editors are to be congratulated in having induced the various authors to write in an uninhibited manner.

G. N. R.

Advances in Computers—Vol. 2 : Edited by Franz L. Alt. (Academic Press, Inc., New York-3), 1962. Pp. xiii + 434. Price $ 14.00. Vol. 3 : Edited by Franz L. Alt and M. Rubinoff. (Academic Press, Inc., New York-3), 1962. Pp. xiii + 361. Price $ 12.00.

The second and third volumes of *Advances in Computers*, in continuation of the first volume, present eleven additional topics in the field. The aim of these volumes is to present the developments in various branches of the subject to the readers in other allied fields who are not specialists in the subject. As stated in the Preface, the articles are not "popular" articles in the usual sense and assume a considerable scientific maturity in the reader. Each of the articles has an extensive list of references which supplement its content.

Volume 2 deals with five topics. The first (J. Douglas) is a survey of finite difference methods for approximating the solutions of partial differential equations of the parabolic type. The second article is a survey (Davis and Rabinowitz) of least square approximation technique in numerical analysis. The third article (K. Shoulders) on Microelectronics is the longest and gives a comprehensive though largely qualitative presentation of the subject, its present achievements and future potentialities. The fourth article (S. I. Gass) deals with the recent developments in linear programming. The last article on the Theory of Automata (R. McNaughton) is a survey of very recent developments in the subject.

The third volume deals with six topics : the computation of Satellite Orbit Trajectories (S. D. Conte), Multiprogramming (E. F. Codd), Recent Developments in Non-linear Programming (P. Wolfe), Alternating Direction Implicit Methods (G. Birkhoff, R. S. Varga and D. Young), Combined Analog-Digital Techniques in Simu-

lation (H. K. Skramstad), and Information Technology and the Law (R. C. Lawlor).

The field of automatic computers is growing so rapidly and in so many directions that few can keep trace with the advances in all aspects of the science. *Advances in Computers* will serve its readers by providing well-written upto-date surveys by experts in the various branches of the science and technology and thereby serve a very useful purpose.

N. S. N.

Non-Glycolytic Pathways of Metabolism of Glucose. By Siegfried Hollmann. Translated and revised by Oscar Touster. (Academic Press, Inc., New York and London), 1964. Pp. ix + 276. Price $ 12.00.

The book under review is an English translation of Professor Hollmann's monograph and has been so revised as to include recent findings in the rapidly expanding field of carbohydrate biochemistry. As is known, three degradative pathways are available for the metabolism of glucose, namely, the glycolytic, pentose phosphate and glucuronic acid cycles. Despite the common belief that the glycolytic pathway is the one of great significance from the point of view of energy supply, it has been found that the latter pathways also assume equal importance as energy yielding mechanisms in some organisms and under certain conditions. Accordingly a critical evaluation of the three pathways is warranted and such a study obviously leads to a study of the metabolism of not only glucose but of other hexoses and pentoses as well. Aminosugars and Deoxysugars being constituents of vital metabolites of the living cell are important products of sugar metabolism and many of these transformations and the synthesis of mucopolysaccharides take place through the mediation of nucleoside diphosphate glycosyl compounds. Many of these aspects have been admirably dealt with in this volume and the regulatory and control mechanism for each pathway are discussed at appropriate places. A discussion, though short, on the clinical aspects of the metabolic anomalies in carbohydrate function envisages diagnosis and a remedy that can be interpreted at the biochemical level. The section on the analytical methods for detection and determination of various important constituents in carbohydrate biochemistry should prove very useful to workers in this field. Surely, this translation work of Oscar Touster has enabled a larger number of research workers

to gain access to an important German contribution in the field of carbohydrate biochemistry.

G. P.

P. S. S.

The Liver—Morphology, Biochemistry and Physiology, Vol. I. (Academic Press, Inc., New York and London), 1963. Pp. xii + 683. Price $ 26.00.

The initiating chapter of this volume presents concepts about the development of hepatic primordia, cholangiogenesis, hepatic malformations and experimental inhibitions of malformations during development of the liver. 'The physiology of embryonic liver' of which very little is known, covers the recent knowledge in the metabolic activities, hæmopoiesis and other functions during embryonic development of this organ.

The liver cell can be defined as a continuous mass of parenchymal cells tunnelled by vessels through which venous blood flows on its way from the gut to the heart. With suitable illustrations, histology of the various structural units of the liver is presented in the chapters, 'Anatomy of the liver', 'The structure of the liver sinusoids' and 'Electron microscopy of the liver'.

Characterization and topographic localization of nucleic acids—RNA and DNA—, proteins, glycogen, lipids, heavy metals and some enzymes in the liver, by histochemical staining reactions, and the implications of these findings in clinical disorders and metabolic functions of the constituent cells are surveyed in the 'Cyto and histochemistry of the liver'.

Current notions in classical histopathology of focal and zonal lesions, cirrhosis, regeneration of hepatic parenchyma and pathoanatomical features of post-necrotic scarring of biliary and cardiac cirrhosis are discussed and a unitary view of all forms of cirrhosis is supported.

The isolation, morphology and biochemistry of 'the cell components of the liver' is an excellent review dealing with techniques of the isolation of cell components ; morphology and composition of nuclei, mitochondria, lysosomes, microsomes and other isolated fractions and the metabolic activity of these cell components.

'The metabolism of amino-acids and proteins,' 'The liver and the lipid metabolism' and 'The liver and carbohydrate metabolism' are chapters that give exhaustive coverage of the rapidly developing knowledge in these fields of study.

M. SIRSI.

Books Received

From : (Academic Press, Inc., 111 Fifth Avenue, New York 10003):

Advances in Applied Mechanics (Vol. 8). Edited by H. L. Dryden and Th. von. Karman, 1964. Pp. x + 298. Price $ 12.00.

The Physiology of Insecta (Vol. I). Edited by M. R. Stein, 1964. Pp. xiv + 640. Price $ 22.00.

Symplectic Geometry. By C. L. Siegel, 1964. Pp. 86. Price $ 4.00.

Carbene Chemistry—Organic Chemistry a Series of Monographs (Vol. I). By W. Kirmse, 1964. Pp. viii + 302. Price $ 9.50.

Scientific Uncertainty and Information. By Leon Brillouin, 1964. Pp. xiv + 164. Price $ 6.50.

The Microscopical Characters of Artificial Inorganic Solid Substances Optical Properties of Artificial Minerals. By A. N. Winchell and H. Winchell, 1964. Pp. xiii + 439. Price $ 14.50.

Silicate Science. By W. Eitel, 1964. Pp. xii + 666. Price $ 24.00.

International Review of Cytology (Vol. 17). Edited by G. H. Bourne and J. F Danielli, 1964. Pp. viii + 401. Price $ 16.00.

Selenium, Geobotany, Biochemistry, Toxicity and Nutrition. By I. Rosenfeld and O. A. Beath, 1964. Pp. xii + 411. Price $ 15.00.

Point Set Topology. By S. A. Gaal, 1964. Pp. xi + 317. Price $ 9.75.

Isotopes in Biology. By G. Wolfe, 1964. Pp. x + 173. Price $ 5.50.

Recent Progress in Surface Science (Vol. 2). Edited by J. F. Danielli, K. G. A. Pankhurst and A. C. Riddiford, 1964. Pp. xiii + 541. $ 18.00.

Experimental Endocrinology—Sourcebook of Basic Techniques. By M. X. Zarrow, J. M. Yochim and J. L. McCarthy, 1964. Pp. xvi + 519. Price $ 15.00.

Lectures on Invariant Subspaces. By H. Helson, 1964. Pp. xi + 130. Price $ 5.00.

Physical Acoustics (Vol. I, Part B)—*Principles, Methods and Devices.* Edited by W. P. Mason, 1964. Pp. xii + 376. Price $ 13.50.

Analytical Methods for Pesticides, Plant Growth Regulators and Food Additives (Vol. IV)—*Herbicides.* Edited by G. Zweig, 1964. Pp. xiii + 269. Price $ 12.00.

International Review of Connective Tissue Research (Vol. 2). Edited by D. A. Hall, 1964. Pp. xiii + 350. Price 93 sh.

Advances in Inorganic Chemistry and Radiochemistry (Vol. 6). Edited by R. J. Emeleus and A. G. Sharpe, 1964. Pp. ix + 530. Price $ 16.00.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Shri Y. V Ramana Murty for his thesis entitled "Studies on Ionospheric Absorption of Short Radio Waves"; Ph.D. Degree in Physics to Shri A. Sanyasi Rao for his thesis entitled "Studies on Horizontal Drifts in the Ionosphere at Waltair"; Ph.D. Degree in Chemistry to Shri Ch. Venkateswarlu for his thesis entitled "Spectrophotometric Studies of Titanium Complexes with Organic Ligands".

M.S. University of Baroda has awarded the Ph.D. Degree in Zoology to Shri K. S. Sadasivan Nair for his thesis entitled "Studies on Certain Aspects of the Physiology of the Furniture-Carpet Beetle, *Anthrenus vorax* Waterhouse (Dermestidae, Coleoptera)".

Osmania University has awarded the Ph.D. Degree in Zoology to Shri Mir Mouzzam Ali for his thesis entitled "Studies on the Nematode Parasites of the Domesticated and Game Birds of A.P. (India)".

Utkal University has awarded the Ph.D. Degree in Agricultural Botany to Shri J. K. Roy for his thesis entitled "Anatomical Studies in the Genus *Oryza*".

Lady Tata Memorial Trust Research Scholarships (1965-66)

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1965-66 commencing from 1st July 1965. Applicants must be of Indian nationality and *Graduates in Medicine or Science* of a recognised University. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1965. Candidates can obtain these instructions and other information they desire from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

Symposium on "Impact of Mendelism on Agriculture, Biology and Medicine"

To commemorate the Twenty-fifth year of the Indian Society of Genetics and Plant Breeding, and also the centenary of Mendel's discovery of the laws of heredity, there will be held an international symposium on "The impact of Mendelism on agriculture, biology and medicine", on February 15th to 20th, 1965 at the Indian Agricultural Research Institute, (I.A.R.I.), New Delhi. The symposium will be inaugurated at 9–15 A.M. on 15th February 1965 in the auditorium of the I.A.R.I. This will be followed by an address on "the role of macro-mutations in evolution and plant breeding" by Dr. M. S. Swaminathan, President of the Society.

Besides the scientific programme of presentation of papers and discussions there will be popular lectures on topics of general interest on the evenings of 15th, 16th, 18th and 19th February.

Science Progress

The October issue of *Science Progress*, the quarterly review journal of current scientific advance, contains the following articles: Electron microscopy of viruses by R. W. Horne; Elementary particles—Simple or complex? by Prof. S. Devons; Metal-metal bonds in transition metal complexes by Prof. J. Lewis; Bonds between dyes and fibres by Prof. I. D. Rattee.

The topics selected for the section on Recent Advances are : Astronomy : The age of the orion nebula ; Physical Chemistry : Chemical reactions in crossed molecular beams ; Metallurgy : Research on the metallurgy of niobium at the University of Sheffield. Geology : Charnockites ; Biochemistry : Vitamin B_6 ; Biology : Ribosomes and protein systhesis.

Theory of Gravitational Collapse to Account for Energy of Stellar Radio Sources

The radio sources with stellar-like images, of which 3C 48 and 3C 273 are examples, appear to be objects with very small diameters yet whose total energies lie in the range 10^{60} to 10^{61} erg. If this is so, the problem of accounting for such high energies in bodies of small size arises. It has been suggested by Hoyle and Fowler that a possible answer to the question lies in the Newtonian theory of the gravitational potential energy of a highly compressed mass. The numerical value of this potential energy for a spherical mass M of radius R is $\delta(GM^2/R)$ where δ has the value 3/5 if the density is constant, and $3/(5-n)$ if the configuration is a complete polytrope of index n. If for simplicity $\delta = 1$, and the mass is equal to 10^6 M$\odot$ (solar mass), a gravitational potential energy of 10^{60} erg is obtained when the mass is compressed into a sphere of radius equal to $3 \cdot 8$ R $\odot$ and it then has an everage denity of $2 \cdot 57 \times$

10^4 gm./cm.^{3} Densities of this order have hitherto been regarded as characteristic of white dwarfs. However, if a mass of 10^8 $M\odot$ is considered, a gravitational potential energy of 10^{60} erg is obtained when the sphere has a radius $3 \cdot 8 \times 10^4$ $R\odot$ and an average density of $2 \cdot 57 \times 10^{-6}$ gm./cm.^{3}, a much less extreme physical condition. The problem is therefore to show how masses of 10^6–10^8 $M\odot$ could be compressed into such small volumes, for until this is achieved, the gravitational potential energy will not attain the desired values.

In an article to the *Astrophysical Journal* Prof. G. C. Mc Vittie examines the existing theory of the collapse of a spherically symmetric mass to a configuration of very small radius, and extends it according to general relativity theory, and also according to Newtonian hydrodynamics with gravitation. The treatments are essentially macroscopic in which the physical state of the material is characterized phenomenologically by a pressure, a density, and a constant ratio of specific heats. It is also assumed that the implosion of matter can be regarded as continuous from the hydrodynamical point of view.—(*Astrophys. Jour.*, 1964, **140**, 401.)

Observation of a Photon Echo

An experiment has been reported in which a small specimen of a ruby crystal is made to emit spontaneously an intense burst of radiation after it has been subjected to two exciting pulses of laser radiation one after the other in quick succession. The spontaneous emission is called a photon echo, and the observation may be compared to similar observations in nuclear magnetic spin echo experiments.

In the experiment a Q-switched ruby laser is triggered to produce an intense pulse of 10 n sec duration. This pulse is split by a beam splitter so that one part is focused on to a small 1 mm. thick ruby crystal ($0 \cdot 005\%$ Cr), while the other part of the beam is directed to an optical delay line to obtain the second pulse, after a short interval $\triangle t$, which is also focused onto the crystal sample at the same spot as the first but at a small but non-zero angle ϕ. The 'echo' leaves the crystal after the same interval $\triangle t$ after the second exciting pulse, and in a direction 2ϕ from the direction of the incident pulse.

The phenomenon may be explained somewhat on the following lines : The first excitation pulse creates a superradiant state in the ruby sample, which because of the large oscillating macroscopic electric dipole moment, radiates strongly until it either decays to the ground state or loses phase coherence. In this experiment the dephasing process is dominant and is caused primarily by inhomogeneous crystal strains. After the dipole moment has dephased, a second excitation pulse is applied which essentially performs a time-reversal operation so that the system now starts rephasing. At a time after the second excitation pulse equal to the time separation of the pulses, the rephasing process is complete and the system again exhibits a macroscopic electric dipole moment resulting in a burst of coherent radiation.

The sample crystal is cooled to liquid helium temperature to obtain relaxation times which are not short compared to the exciting pulse separation.—(*Phys. Rev. Letters*, November 9, 1964.)

Attenuating Thermal Energy Blast Waves

J. Wadsworth of the National Aeronautics Establishment (NRC), Ottawa, writes in *Nature* : It has been observed that when an explosive charge of TNT is intimately surrounded by a light crushable porous solid of large surface area and high heat capacity, the subsequent blast wave is rapidly attenuated. The mechanism of attenuation is hazarded as mainly heat transfer. The crushable nature of the surrounding porous solid (no elasticity—zero velocity of sound) would prevent immediate transmission of the blast wave energy and allow time for multiple reflections, hence heat transfer and therefore attenuation, as gas flow is established through the porous solid.

Although a large number of materials would be suitable as the attenuating medium, initial experimentation has been confined to exfoliated mica, that is vermiculite. The advantages of this material are its almost insignificant cost and its chemical inertness.

Experience has indicated that the use of vermiculite is a very convenient laboratory tool. A charge of TNT weighing 1/3 lb. can be detonated at the centre of a simple wooden box ($4 \times 4 \times 4$ ft.) filled with vermiculite, with complete safety. In fact very little audible signal is received outside the box. Extrapolation emphasizes the possibility of obscuring the detonation of some 1,000 tons of TNT in a pile of vermiculite of the order of 100 ft. in height. The attenuating mechanism becomes more effective the higher the temperature of the explosive source.—(*Nature,* 1964, **204**, 673.)

THE NEW PHYSIOLOGY OF VISION

Chapter X. The Major Visual Pigments

SIR C. V. RAMAN

THE two preceding chapters of this treatise dealt with the part of the spectrum in the wavelength range between 400 mμ and 500 mμ and elucidated the nature of the visual process by which the colours ranging from blue to violet in that region are perceived. We next proceed to explore the rest of the spectrum in the wavelength range between 500 mμ and 700 mμ with a view to discover what the characters of the spectrum in this region can reveal to us regarding its origin.

Visual inspection enables the spectrum between 500 mμ and 700 mμ to be divided roughly into three parts. The first part between 500 mμ and 550 mμ may be described as the green sector of the spectrum. In the second part which ranges between 550 mμ and 600 mμ we observe a rapid progression of colour, from green to a greenish-yellow and then to a pure yellow and beyond this again to an orange-yellow hue and then orange. The third part of the spectrum between 600 mμ and 700 mμ exhibits colours ranging from orange to crimson red through various intermediate hues. The colour sequence thus summed up has in the past been sought to be explained as the result of the superposition of the "fundamental" sensations of green and red respectively, their relative importance varying over the range, green being dominant at one end and red at the other. That this view is erroneous and needs to be rejected becomes clear when the actual facts of the case are set out and we consider their theoretical significance.

The most striking feature of the spectral range between 550 mμ and 600 mμ is the appearance within that range of a strip exhibiting a pure yellow hue. This colour presents no similarity either to the green or to the red of the spectrum, while the colours observed on either side of the strip may be described as a superposition upon a pure yellow sensation of weaker green and red sensations respectively, their proportion to the yellow increasing as we move away from the wavelength at which the sensation perceived is pure yellow. It may be remarked also that the pure yellow appears in the spectrum in a region where the luminous efficiency is very high and indeed not much less than the maximum.

The facts stated above justify us in recognising the wavelength range between 550 mμ and 600 mμ as that in which yellow is the dominant sensation. We may also justifiably infer that the yellow sensation results from the presence in the retina of a pigment which has an absorption peak at the point where the pure yellow sensation manifests itself in the spectrum. Thus, instead of relegating the yellow of the spectrum to the position of a minor or secondary sensation, we accord to it its rightful place as the principal or major visual sensation, while blue, green and red which appear in the parts of the spectrum where the luminous efficiency is smaller and which are indeed the most colourful parts of the spectrum should nevertheless be considered as playing only a minor role in vision. The identification of the visual pigment which functions as the receptor of the yellow in the spectrum accordingly assumes very special importance.

The statement that yellow is the major visual sensation is no more than an explicit recognition of the factual situation. Inevitably, therefore, such recognition is essential for a satisfactory or successful elucidation of the entire body of visual experiences in the field of colour. In particular, when we examine the hues exhibited by various objects in daylight and seek to correlate them with the spectral character of the light diffused or scattered by the object and reaching the eyes of the observer, we find that the presence or absence of the yellow in that spectrum plays the determining role. We shall not here enter more deeply into this subject, as it will be dealt with very fully in later chapters under the heading of the visual synthesis of colour. In the present chapter, we shall concern ourself principally with the identification of the visual pigment in the retina which enables us to perceive the yellow sensation. For this purpose, we shall consider the characteristics of the spectrum in greater detail.

Hue Discrimination in the Spectrum.—As has already been remarked, a rapid progression of colour is noticeable in the spectral range between 550 mμ and 600 mμ. Many authors have determined the minimum change of wavelength necessary at various points in the spectrum to produce an observable change of hue. There is general

agreement that the shift of wavelength needed is everywhere rather small except near the very ends of the spectrum. It is exceptionally small at two particular points in the spectrum; one of them is at 490 mμ where the blue of the spectrum changes over rapidly to green. The other point is at 579 mμ where the spectrum exhibits a pure yellow hue, the observed colour changing rapidly to a greenish-yellow and to an orange-yellow respectively on the two sides of it.
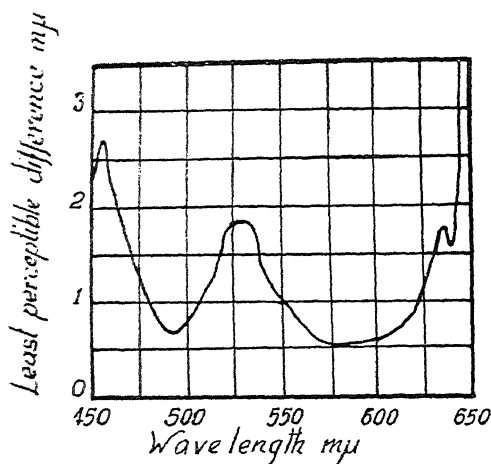
FIG. 1. Curve of Hue Discrimination.

Figure 1 reproduces the results of an extremely thorough and accurate study of hue discrimination made at the Bureau of Standards in Washington by E. P. T. Tyndall, and presented as a graph in a paper by that author (*Jour. Opt. Soc. Am.*, Vol. 23. 1933, page 15). It will be noticed from the graph that the least perceptible difference in wavelength reaches its minimum value of 0·5 mμ at 579 mμ. That this is exactly where the spectrum exhibits the pure yellow colour is readily verified by observation. Visual comparison in a wavelength spectrometer of the two lines of the mercury arc spectrum appearing at 5770 A and 5790 A reveals that the two lines differ noticeably in colour, the former appearing distinctly greenish in hue, while the latter appears as a perfect yellow. Placing a marker in a continuous spectrum at the point separating the greenish-yellow from the orange-yellow regions and taking the average of a series of readings, the mean comes out as 579·5 mμ ± 0·5 mμ. This agrees very closely with the point in Tyndall's graph at which the power of hue discrimination is at its highest.
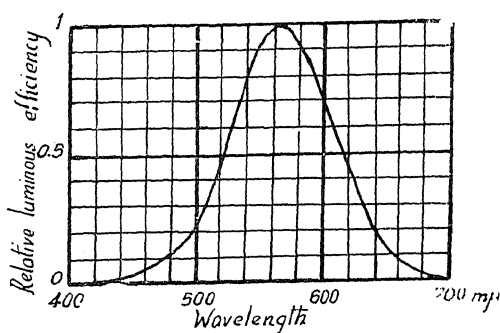
FIG. 2. Luminous Efficiency in the Spectrum.

It is evident from what has been stated above that the curve of hue discrimination is of great importance in its bearing on the visual processes which result in the perception of colour. It is necessary, however, to consider its indications along with those furnished by the curve exhibiting the variations of luminous efficiency over the visible spectrum. Figure 2 exhibits the form of that curve for foveal vision as actually determined. It will be seen that the luminous efficiency reaches its maximum value at 565 mμ. But as the efficiency falls off from the maximum more slowly towards greater wavelengths, the efficiency in the yellow at 580 mμ is not markedly smaller than the maximum. On the other hand, it will be seen from the figure that the luminous efficiency falls to much smaller values at 530 mμ and 630 mμ which are the wavelengths at which the colours in the spectrum are respectively pure green and pure red.

The remarkably high power of colour discrimination exhibited at 579 mμ, also to a lesser extent on either side of 579 mμ is a clear indication that these features have their origin in a powerful absorption by a visual pigment having a well-defined peak of absorption at 579 mμ. But the maximum of luminous efficiency appears at 565 mμ and not at 579 mμ. Likewise, the hue discrimination curve exhibits a markedly asymmetrical course, running steeply between 550 mμ and 579 mμ and much less steeply between 579 mμ and 600 mμ. These features indicate that other visual pigments also play a not unimportant role in these spectral regions.

Identification of the Principal Visual Pigment. —The blood-pigment heme in its various forms is known to exhibit an extremely powerful absorption of light in the spectral range with which we are now concerned. Since the presence of heme in one form or another within the

substance of the retina can be safely assumed, we may proceed to examine whether its known spectroscopic behaviour can furnish a clue to the explanation of the facts of colour perception in human vision.

Heme is present in human blood principally as the compound known as oxyhemoglobin which gives it a red colour. The addition of a drop or two of blood to water contained in a cuvette results in the exhibition of a powerful absorption of light. Examination through a spectroscope reveals a sharply-defined dark band at 579 mμ and a much broader and weaker absorption band around 546 mμ. Reduction of the pigment to the form of hemoglobin by the addition of a little sodium dithionate results in a remarkable change in the characters of the absorption. It then manifests itself as a diffuse band of which the maximum may be located around 555 mμ. These facts are clearly brought out in Fig. 3 in which the absorption curves of oxyhemoglobin and hemoglobin determined spectrophotometrically have been exhibited.

bands of oxyhemoglobin have been marked therein as 579 mμ and 546 mμ respectively.

The exact coincidence of the absorption at 579 mμ exhibited by oxygenated blood with the position in a continuous spectrum of the strip exhibiting a pure yellow colour can be readily verified by holding a cuvette containing water to which a few drops of blood have been added behind the eye-piece of a wavelength spectrometer and viewing a continuous spectrum through it. The absorption band just covers the yellow strip in the spectrum, while measurements with the wavelength drum give the position of its centre as 579 mμ. The inference appears fully justified that the heme pigment in the fully oxygenated form is present in the human retina and that it is indeed the principal visual pigment which enables us to perceive the most highly luminous part of the spectrum. This inference is further confirmed and reinforced when it is remarked that the sharpness of the absorption band at 579 mμ and its great intensity are matched by the narrowness of the strip in the spectrum exhibiting the pure yellow colour and the very high luminous efficiency of the part of the spectrum in which it appears.

FIG. 3. Absorption Curves of the Blood Pigment.

The curves have been copied from a paper by David L. Drabkin appearing in the *Barcroft Memorial Volume on Hemoglobin* (Butterworth's, London, 1949). In another paper appearing in the same publication, Felix Haurowitz has reproduced spectrum photographs exhibiting similar features ; the positions of the absorption
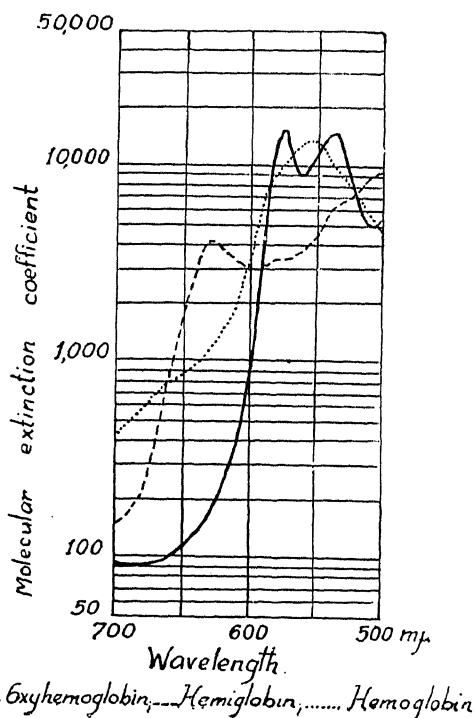
FIG. 4. Molecular Extinction Coefficients of Heme Pigments,

The other Visual Pigments.—As has already been remarked, the heme pigment in its oxidised form would not suffice by itself fully to explain the observed characteristics of the spectrum even within the restricted range of wavelengths between 550 mμ and 600 mμ in which yellow is the dominant sensation. To obtain a complete picture of the situation, we have to consider also the wavelength range between 500 mμ and 550 mμ and the range between 600 mμ and 700 mμ. In these two ranges, the predominant colour sensations are those of green and red respectively. It may reasonably be inferred that we are also concerned with two other visual pigments whose contributions to the luminous efficiency are important respectively in these two regions.

It is well known that there are two other pigments chemically related to oxyhemoglobin which are known respectively as hemoglobin and hemiglobin. The first of these results from the action of reducing agents on oxyhemoglobin and the second by its auto-oxidation. It may therefore reasonably be assumed that the human retina contains three pigments based on heme whose spectroscopic behaviours are respectively similar to oxyhemoglobin, hemoglobin and hemiglobin.

Figure 4 exhibits the molecular extinction coefficients of these three pigments over the wavelength range between 500 mμ and 700 mμ, reproduced in part from the plate at the end of the book by Lemberg and Legge on *Hematin Compounds* (Interscience, New York and London, 1949). The proportions in which the three pigments are present in the retina would determine their contributions to the perception of luminosity and colour in the spectrum. In a general way, it can be seen that the superposed effects of the three pigments would explain the observed characteristics of the spectrum in respect of colour and luminosity over the range of wavelengths between 500 mμ and 700 mμ. Particularly noteworthy is the fact that a steep drop in the molecular extinction coefficient of hemiglobin appears at about 630 mμ (*see* Fig. 4), while there appears in Fig. 1 a sharp dip in the hue-discrimination curve at about the same wavelength. A steep drop in the molecular absorption coefficient of one of the visual pigments operating in this region would necessarily result in a marked improvement in hue discrimination at the same wavelength.

CRYSTAL SYMMETRY AND MAGNETIC PROPERTIES

S. BHAGAVANTAM

A CRYSTAL is built by an infinite periodic repetition in space of identical structural units. Conventionally, by the symmetry of a crystal is meant the symmetry of its spatial structure. The set of all spatial transformations which transform every point of such a structure into another point equivalent to it and also every direction into an equivalent one, forms a group which is called the space group of the crystal. There are 230 space groups and it is well known that these space groups constitute the basis for all the distinct patterns that can be identified in crystals. If we consider only the symmetry of directions at a point in a crystal, the set of all rotations and rotation-inversions which transform every direction of the structure into an equivalent direction form a group which is called the point group of the crystal. There are 32 distinct point groups of spatial transformations and these are called the 32 classes in crystallography.

The macroscopic properties of a crystal depend only on its symmetry of directions which is its point group symmetry. This dependence of the macroscopic properties of a crystal on its point group symmetry is given by Neumann's principle, which states that "every physical property of a crystal must possess at least the symmetry of the point group of the crystal". This principle, put forward by Neumann, is of fundamental significance and needs to be examined with great care in regard to the nature of physical properties one wants to deal with as well as the concept of symmetry one has in mind when one is referring to a crystal.

Since the discovery of X-rays and of even more powerful tools for investigating the internal structure of crystals, our knowledge of the crystal structure has deepened. We know that the theoretically expected spatial structure of a crystal agrees with the spatial disposition

of time-average electron charge density in it and the positions of the nuclei as revealed by X-ray analysis. We are even able to explain how such a structure is responsible for several physical properties exhibited by the crystal. The successes achieved in this manner of describing the crystal structure and explaining the physical behaviour of the crystal have led to an inadvertent imposition of the point group symmetry of a crystal on all its physical properties.

That such an imposition is erroneous becomes evident when we consider certain magnetic properties of crystals which have been, till recently, elusive in a way. For instance, P. Curie conjectured the possibility of pyromagnetism and piezomagnetism being exhibited by circularly asymmetric crystals. Pyromagnetism is the appearance of magnetic moment on the application of temperature. Piezomagnetism is the appearance of magnetic moment on the application of stress. He made extensive investigations to demonstrate these phenomena but did not meet with success.

Voigt considered these effects as probable and determined the possible schemes of non-vanishing constants in respect of these properties in the 32 classical crystal classes—assuming erroneously again that these properties also, when manifest in a crystal, should possess the appropriate classical point group symmetry.

As recently as 1953, Zocher and Torok[1] analysed this situation, making use of Wigner's concept of time-inversion symmetry. Time-inversion is not a possible physical act, but can be implied as a concept in a study of a set of events in the opposite chronological order. Quantities like linear velocities are time-asymmetric. They concluded that under the operation of inversion, electric field is space-asymmetric and time-symmetric whereas magnetic field is space-symmetric but time-asymmetric. It follows that properties like magnetic moment and hence piezomagnetism and pyromagnetism are also time-asymmetric. Assuming that the structure of a crystal is time-symmetric, they concluded that time-asymmetric properties like pyromagnetism and piezomagnetism cannot exist in crystals at all.

On the other hand the Russian school appears to have been, for quite some time, cognizant of certain special features of symmetry in the structure of crystals which one has to take into account when magnetic properties are considered. In a crystal, the component parts are actually in continual motion. The distribution

of electric current due to moving electrons is such that ∫ J dV taken over the volume of a unit cell must vanish when averaged over time. But this does not preclude the currents from producing a macroscopic magnetic moment. The symmetry of the current distribution should correspond to that of the distribution and orientations of atomic magnetic moments. The ferromagnetic and antiferromagnetic crystals are now known to be characterised by an orderly distribution of such magnetic moments. If the crystal is built from atoms which have non-vanishing magnetic moments (spins), then this spin becomes an additional special feature of symmetry (besides its spatial symmetry) of the motif whose periodic repetition gives rise to the crystal structure.

In 1951, Shubnikov thought of spatial structures in which the motifs are geometrically identical, but can be conceived of as existing in two different forms on some other basis. He assumed them to be coloured black or white. If a spatial symmetry operation followed by a change of black into white and white into black is recognised as a single symmetry operation, which may be called a complementary symmetry operation, it can be shown that the number of distinguishable patterns increases from 230 to 1421 and the number of point groups from 32 to 90.

In ferromagnetic or antiferromagnetic structures, the neighbouring atomic magnetic moments are either parallel or anti-parallel. In such a structure, one can define a complementary symmetry operation as consisting of an ordinary spatial transformation followed by a reversal of spins. It may turn out that a usual symmetry operation of spatial transformation, while bringing the geometrical structure into coincidence with itself, may result in the reversal of the orientation of spins. In such a case the complement of that operation as defined above will be a symmetry operation. It may be pointed out here that a reversal of spins corresponds to a reversal of micro-currents that are responsible for the magnetic moments. This, in essence, is not different from the concept of time-inversion.

The recognition of new complementary symmetry operations increases the possible number of crystal classes to 90. We can call them magnetic point groups or magnetic classes. They include the 32 classical point groups. For a simple derivation of the magnetic classes one may refer to a recent publication by Bhagavantam and Pantulu.[2]

The ferromagnetic and antiferromagnetic

structures possess either ordinary operations or complementary operations or both as symmetry operations, but the single operation of reversal of spins is not a symmetry operation for them. Such structures may be described as being time-asymmetric. It is at once evident, as pointed out by Dzialoshinskii,[3] that arguments put forward to show that pyromagnetism and piezomagnetism are not possible are valid only for paramagnetic crystals. In fact he showed that it is possible for substances possessing antiferromagnetic structures to exhibit piezomagnetism. In 1955, Borovik-Romanov[4] confirmed these predictions by demonstrating the existence of piezomagnetic effect in CoF_2 and MnF_2 and measuring the dependence thereof on temperature in CoF_2.

We can here go back to the general problem of crystal symmetry and its influence on physical properties. It will be helpful to remind ourselves that there is no absolute definition for the symmetry of a crystal or of any object. There is always a context or attitude with reference to which the symmetry of an object is understood and described. The fact that almost all animals have a bilateral symmetry of external form, but that no such symmetry exists if the structure of their internal organs is taken into account is an easily understood example from the field of biology. Likewise the result of an experimental determination of the point group symmetry of a crystal depends on the kind of external means we choose to apply and observe its effect. For example. the study of the Laue patterns reveals only 11 distinct classes and not 32. Such methods cannot in themselves give direct information on the presence or absence of a centre of symmetry. In fact, every crystal diffracts X-rays as if a centre of symmetry were present.

The term "symmetry of the crystal" needs qualification in view of the generalisations mentioned. If it is a magnetic property which is influenced by the magnetic structure in a crystal that we wish to discuss, the appropriate magnetic class of the crystal defines the symmetry of the crystal. In a similar manner we have to amplify Neumann's principle. If the physical property under study depends on the magnetic structure of the crystal in which it is observed, Neumann's principle should be understood as laying down that the physical property possesses at least the magnetic point group symmetry of the crystal.

That these generalisations in the concept of symmetry are significant can be seen from the results given by Bhagavantam and Pantulu.[2] In that work, a group theoretical method given earlier by Bhagavantam to obtain the number of non-vanishing independent constants of a physical property subject to a point group symmetry has been extended to obtain similar results for pyromagnetism, magnetoelectric polarizability and piezomagnetism in respect of the 90 magnetic classes. It has been shown that the property of pyromagnetism is possible in 31 classes. 14 of these 31 classes are from the classical point groups and would be the only ones recognised as pyromagnetic classes, if spatial symmetry alone is taken into account. The remaining 17 classes arise out of the possibility that each classical point group can give rise to magnetic variants. A magnetic variant is a magnetic class derivable from the classical class. If the concept of magnetic symmetry is not recognised, all crystals possessing the spatial symmetry appropriate to the classes of which these seventeen are magnetic variants would have been regarded as incapable of exhibiting pyromagnetism. Similar considerations can be extended to other properties.

A particular example in piezomagnetism which received experimental confirmation may also be mentioned. CoF_2 and MnF_2 belong to the magnetic crystal class 4/m m m. Piezomagnetism for this crystal class is characterised by two independent non-vanishing constants. This has been experimentally verified by Borovik-Romanov. On the other hand, if we treat the crystals as belonging to classical crystal class 4/m m m, ignoring magnetic symmetry, piezomagnetism is still possible but should be characterised by only one independent non-vanishing constant.

From these considerations it is evident that the generalisations in regard to the concepts of symmetry discussed in the foregoing pages are of great significance while studying the physical properties of crystals.

1. Zocher. H. and Torok, C., *Proc. Nat. Acad. Sci.*, 1953, 39, 681.

2. Bhagavantam, S., and Pantulu, P. V,, *Proc. Ind. Acad. Sci.*, 1964, 59, 1.

3. Dzialoshinski, I. E., *Soviet Physics*, J.E.T.P., 1958, 6, 621.

4. Borovik-Romanov, A. S., *Ibid.*, 1959, 9, 1390.

ULTRA-VIOLET EMISSION SPECTRA OF XENON AND KRYPTON FLUORIDES

S. L. N. G. KRISHNAMACHARI, N. A. NARASIMHAM AND MAHAVIR SINGH

Spectroscopy Division, Atomic Energy Establishment, Trombay, Bombay

INTRODUCTION

IN June 1962, Neil Bartlett[1] of the University of British Columbia reported a reaction of xenon with platinum hexafluoride. This was later confirmed by Claassen *et al.*[2] at the Argonne National Laboratory who further established that the rare gas xenon reacted directly with

EXPERIMENTAL

An electrodeless discharge through mixture of BF_3 and xenon excited by means of a microwave oscillator (frequency 2,450 Mc./sec.) gave two intense groups of bands at 3510 Å and 3080 Å and two relatively weaker ones at 2635 Å and 2355 Å (Fig. 1). So far as we could
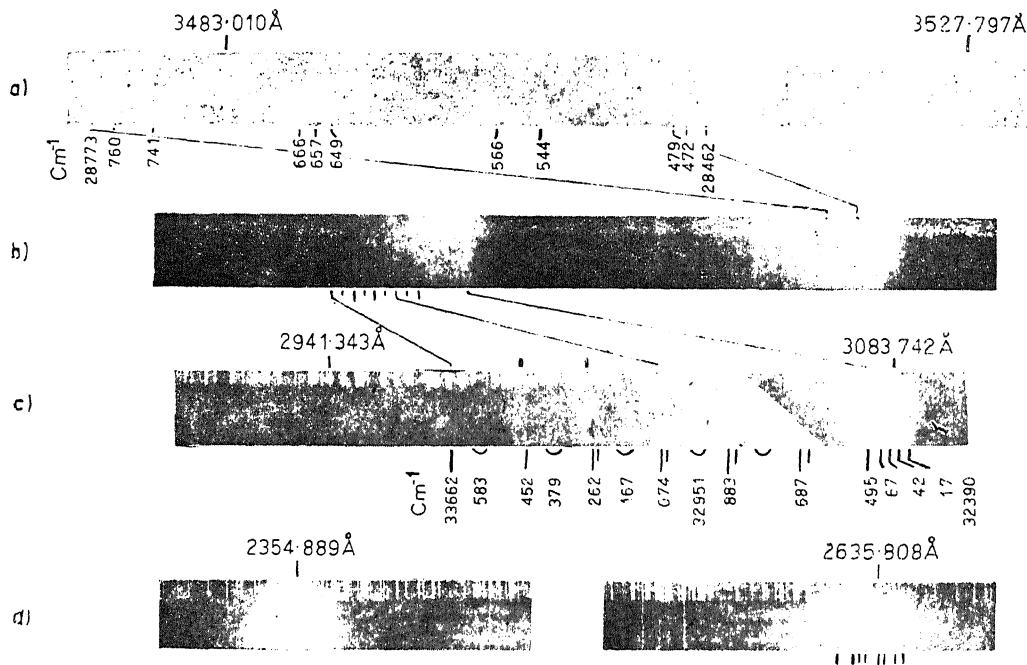
FIG. 1. Emission bands obtained in discharges through Xenon and LiF. (*a*) 3510 Å band recorded in the second order of 6·6 metre concave grating spectrograph. (*b*) 3080 Å and 3510 Å bands recorded on a Hilger medium quartz spectrograph. (*c*) 3080 Å band recorded on a Bausch and Lomb large quartz spectrograph. (*d*) 2635 Å and 2355 Å bands recorded on a Hilger medium quartz spectrograph.

fluorine. Immediately afterwards a number of xenon fluorides, *viz.,* XeF_4, XeF_2, $XeOF_4$ were prepared and identified. Soon after, krypton also was found to form fluorides, though much less readily.[4] These discoveries stimulated great interest in the chemistry of rare gases which were hitherto supposed to be absolutely inert. During the course of our investigations on the emission spectra obtained in discharges through BF_3 in the presence of xenon and krypton, we have obtained certain spectral features in the region 2200 Å to 3500 Å which are attributable to fluorides of xenon and krypton. Results of these investigations are briefly presented in this report.

ascertain, these bands do not belong to any of the known band systems. The spectra of BF, BO and BO_2 molecules were also obtained in these discharges; however, they do not interfere with the above bands and further by adjusting the experimental conditions they could be largely suppressed. The bands could be obtained with equal ease when BF_3 was replaced by LiF or NaF. However, since these are solids, it was found necessary to heat them in the discharge tube initially to about 300° C.

There was no enhancement of the intensity of these bands when oxygen was introduced into the system. The most favourable condition was found to be that when the pressure of xenon in

the discharge tube was about 10–15 cm. and the discharge was in the form of streaks.

During preliminary studies, the spectra were recorded on Hilger quartz spectrographs of small and medium dispersions. Since the bands at 3510 A and 3080 A are the more intense ones in each group, they are photographed at higher dispersion. Figure 1 (a) represents part of the 3510 A band taken in the second order of the 6·6 metre concave grating spectrograph at a dispersion of 0·55 A/mm. while Fig. 1 (c) represents the 3080 Å band taken on a Bausch and Lomb large quartz spectrograph at a dispersion of 5 A/mm. The weaker bands at 2635 Å and 2355 Å are photographed on a Hilger medium quartz spectrograph having a dispersion of 8 A/mm. at 2500 Å.

Analogous experiments with krypton in place of xenon gave only two spectral features at 2485 Å and 2220 Å (Fig. 2).

about the same as that between the centres of the 3080 Å and 2355 A bands ($\sim 10,000$ cm.$^{-1}$). Furthermore this separation is rather close to the ground state doublet separation of the ionised xenon atom (10,537 cm.$^{-1}$) and appears to be significant.

(a) *Bands at 3510 Å and 2635 Å.*—The feature at 3510 Å is easily the most complex of all the bands observed. The most intense part of this band, when photographed on the 6·6 metre grating spectrograph, exhibits four groups of bands separated from one another by ~ 100 cm.$^{-1}$ Each of these groups appears to possess three to four well-marked heads. Reference to the Fig. 1 (a) will show that the band extends beyond 3510 Å with a structure which appears like the rotational fine structure of a band. Such a structure is also observable, though with lesser intensity, in all the four groups. At wavelengths lower than the last of these four groups, there
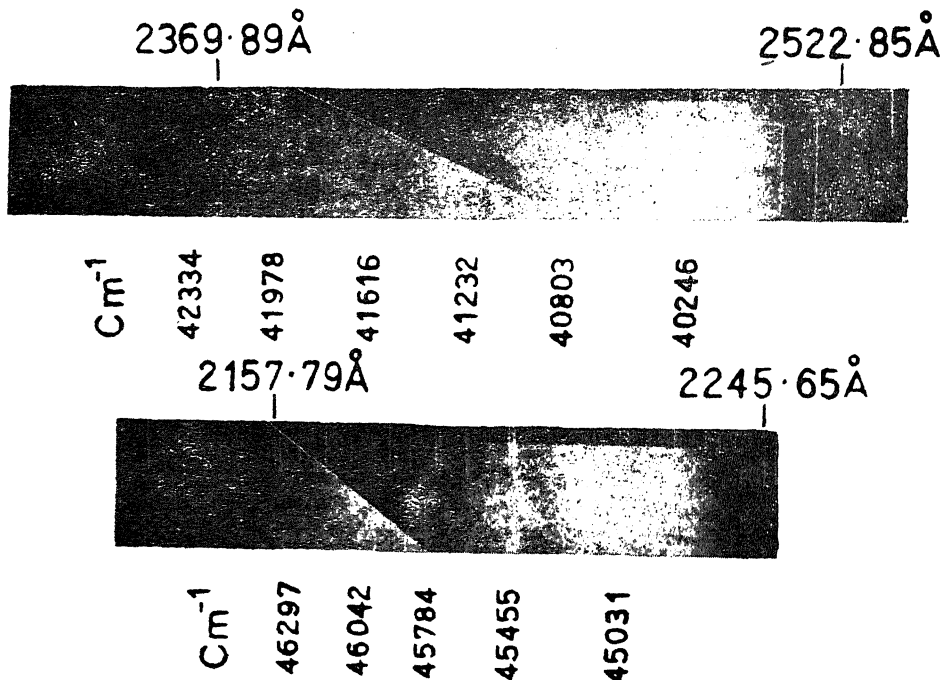
FIG. 2. Emission bands obtained in discharges through Krypton and LiF. (a) 2485 Å band and (b) 2220 Å band recorded on Hilger medium quartz spectrograph.

RESULTS AND DISCUSSION

I. Bands Associated with Xenon.—From similarity in their intensity behaviour, the bands at 3510 Å and 2635 Å are considered to form one group and the 3080 Å and 2355 Å bands another group. It is interesting to note that when so grouped, the interval (~ 9500 cm.$^{-1}$) between the centres of the 3510 Å and 2635 Å bands is

are a few more weaker bands which probably form a progression but these, however, were not photographed in the high dispersion. The 2635 Å band is more diffuse but some eight or nine heads could be measured in its main body. These are shown marked in Fig. 1 (d). This band is also followed by a few much more diffuse and weak bands on the shorter wavelength side.

(b) *Bands at 3080 A and 2355 A.*—Under the resolution employed the 3080 A band is seen to consist of an intense group of closely spaced heads with an average separation of ~ 25 cm.[-1] No further structure of these heads was revealed when the 6·6 metre grating spectrograph was used. This feature of the band appears very much similar to the K structure of a simple polyatomic molecule. This band is followed on the shorter wavelength side by a series of weak, diffuse bands. These could be grouped into two progressions of five or six bands each. One of these progressions consists of bands each of which shows a fairly sharp head followed by a weaker component on the longer wavelength side. These bands occur at separations of ~ 192 cm.[-1] The other progression consists of more diffuse bands having separations estimated to be ~ 210 cm.[-1] The first member of this progression that could be clearly seen on the plate is ~ 300 cm.[-1] from the main head at 3080 A and lies towards its shorter wavelength side. The 2355 A band is completely diffuse with no distinguishable features. The contour of the band however indicates a degradation towards shorter wavelength side. It is realised that no more satisfactory analysis of the 3080 A band could be given. It is possible to regard the above progressions as arising from a series of excited vibrational levels belonging to the two rather similar modes of vibration of an upper electronic state to a lower electronic state of a practically repulsive nature. The diffuseness of the successive members of the progression seems to support this view. If one accepts for argument that the emitter of this band system is XeF_2, the infra-red and Raman data[5] for the ground state of this linear molecule being known to be $\nu_1 = 497$, $\nu_2 = 213$ and $\nu_3 = 555$ cm.[-1], the separations of 192 cm.[-1] and 210 cm.[-1] observed in the two series seem to correlate with the doubly degenerate bending frequency 213 cm.[-1]

II. Bands Associated with Krypton

In the discharge through krypton and LiF, two groups appear at 2485 A and 2220 A. Figure 2 shows these bands photographed on a Hilger medium quartz spectrograph. Here again the separation between the centres of the main heads of the 2485 A and 2220 A bands (~ 4800 cm.[-1]) is about the same as the doublet separation of the ground state of the krypton ion (5371 cm.[-1]). Each of the two systems shows a progression of a diffuse pattern extending towards the shorter wavelength side. From the successive separation in each of the progressions vibrational frequencies of ~ 425 and ~ 560 cm.[-1] could be obtained corresponding to the two upper electronic states involved in the 2220 A and 2485 A systems respectively. Though these values happen to be close to two of the vibrational frequencies $\nu_1 = 449$,[*] $\nu_3 = 580$ cm.[-1] reported for KrF_2,[6] it is not certain how far the correlation would be justified.

Because of the current interest in such molecules it was thought useful to present the distinctive features of the spectra obtained, although the interpretations offered have to be considered provisional.

* Dr. Pimentel has intimated that this frequency of 449 cm.[-1] has been observed by Claassen *et al.* in the Raman spectrum of KrF_2.

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LETTERS TO THE EDITOR

A QUICK METHOD OF DERIVING WISHART'S DISTRIBUTION

THE joint probability differential of n independent observations on the p variates $(X_1, X_2, \ldots, X_p)$ distributed in the multivariate normal form with zero means and covariance matrix Σ is

$$\text{(Constant)}. \exp(-\tfrac{1}{2} tr \, \Sigma^{-1} S) \, dX \qquad (1)$$

where S is the $p \times p$ Wishart matrix

$$\overset{n}{\underset{1}{\Sigma}} (X_\alpha X_\alpha'),$$

and dX is the volume element

$$\Pi \, dX_{ij} \, (i = 1, 2, \ldots p \, ; \, j = 1, 2, \ldots, n).$$

To obtain the distribution of S, integrate (1) in the domain S to $S + dS$, and in the process any function of S can be taken outside the integral sign leading up to

$$\text{(Constant)}. \exp(-\tfrac{1}{2} tr \, \Sigma^{-1} S) \int_{S, S+dS} dX. \qquad (2)$$

The integral, being a function of S, may be taken as $f(S) \, dS$, and therefore the distribution of S is

$$\text{(Constant)}. \exp(-\tfrac{1}{2} tr \, \Sigma^{-1} S) \, f(S) \, dS. \qquad (3)$$

It now remains to determine the nature of the function $f(S)$. To achieve this, introduce a transformation which takes over X to AX^*, the Jacobian of the transformation being $|A|^n$. Therefore

$$\int_{S, S+dS} dX = \int_{S^*, S^*+dS^*} |A|^n \, dX^*$$
$$= |A|^n f(S^*) \, dS^* \qquad (4)$$

where S^* stands for the Wishart matrix of X^* which are distributed as multivariate normal. Since $S = AS^*A'$, the function $f(S) \, dS$ could be transformed by this substitution, the Jacobian in this case being $|A|^{p+1}$. Therefore $f(S) \, dS \rightarrow |A|^{p+1} f(AS^*A') dS^*$. Identifying this with the last member of (4) we get

$$\frac{f(AS^*A')}{|AS^*A'|^{(n-p-1)/2}} = \frac{f(S^*)}{|S^*|^{(n-p-1)/2}}$$

showing that $f(S) / |S|^{(n-p-1)/2}$ is independent of the argument, and is therefore a constant.

This gives the nature of $f(S)$, and substituting this result in (3) the required distribution of S is obtained as

$$\text{(Constant)}. \exp(-\tfrac{1}{2} tr \, \Sigma^{-1} S) \, |S|^{(n-p-1)/2} \, dS. \qquad (5)$$

By using Siegel's lemma the value of the integral

$$\exp(-\tfrac{1}{2} tr \, \Sigma^{-1} S) \, |S|^{(n-p-1)/2} \, dS$$

is found (vide Cramer's Mathematical Methods of Statistics, p. 390) to be equal to

$$|\Sigma|^{n/2} \, 2^{np/2} \pi^{p(p-1)/4} \prod_{i=1}^{p} \Gamma\left(\frac{n-i+1}{2}\right)$$

and the constant in (5) is the reciprocal of this quantity.

This completes the proof of the derivation of Wishart's distribution.

Karnatak University,   M. V. JAMBUNATHAN.
Dharwar, December 22, 1964.

USE OF POTASSIUM THIOCARBONATE (PTC) REAGENT IN THE IDENTIFICATION OF COPPER (II) AND CADMIUM (II) WHEN PRESENT TOGETHER

POTASSIUM thiocarbonate has been earlier reported[1-6] as an efficient sulphide and thiocarbonate precipitant replacing the conventional use of gaseous hydrogen sulphide in the systematic cation groups separation involving common and less common metals. In the present communication, the soluble coloured complex formation property of PTC with certain d-transitional metals has been applied to the separation and identification of Copper (II) and Cadmium (II).

Despite the various available methods, detection of cadmium in the presence of copper is often attended with difficulty. However, the methods based on the complex cyanides of the two metals have found much favour. The complex, $[Cd(CN)_4]^{2-}$ having relatively much higher instability constant (1.4×10^{-17}) than that (5.0×10^{-28}) of $[Cu(CN)_4]^{3-}$ yields precipitates of $Cd(OH)_2$ and CdS on treatment with formaldehyde[7] and hydrogen sulphide[8,9] respectively, leaving the copper cyanide-complex intact in solution. But requirement of control of soln. pH and the toxicity hazard of alkali cyanide restrict its use by a large group of students. Against this, the use of PTC offers safe and efficient analytical separation of the two metals irrespective of the quantities involved.

Procedure.—The solution, containing Cu^{2+} and Cd^{2+}, after the removal of other member-cations

of cadmium group, is taken in a centrifuge cone and made ammoniacal to yield $[Cu(NH_3)]^{2+}$ and $[Cd(NH_3)_4]^{2+}$. To this $0.5 M$ aq. soln. of K_2CS_3 is added dropwise. Initially, copper and cadmium are both precipitated as $CuCS_3$ (brown) and $CdCS_3$ (yellowish-orange) respectively. But on continued dropwise addition of K_2CS_3 soln. and warming at $60°$ C. by placing the cone in a water-bath, reddish coloured soluble complex, $K_2[Cu(CS_3)_2]$ is obtained, while the ppt. of $CdCS_3$ remains unaffected with excess K_2CS_3. The two are separated by centrifuging. The centrifugate containing $K_2[Cu(CS_3)_2]$ is withdrawn and separately acidified with HCl to yield black ppt. of CuS on digestion on steam-bath. The treatment of the reddish centrifugate with HCl is an essential step for the confirmation of copper especially when it is present in relatively smaller amounts.

Modified Procedure in the Presence of Nickel and Cobalt.—Nickel (II) when treated with K_2CS_3 in ammoniacal medium yields initially a purple-red product, $[Ni(NH_3)_4]CS_3$, which with excess of the thiocarbonate reagent results in forming the blood-red complex, $K_2[Ni(CS_3)_2]$. Cobalt (II) under similar conditions forms the brownish-black complex, $K_2[Co(CS_3)_2]$. As such, in the presence of nickel or cobalt, the centrifugate after separation from $CdCS_3$ would be intense red, or brownish thereby masking the reddish colour due to copper when present. However, the intense coloured nickel and cobalt complexes are easily decomposed with a few drops of H_2O_2 on heating whereas the copper complex, $K_2[Cu(CS_3)_2]$, yields brown ppt. of $CuO.XH_2O$. Alternatively, on treatment of the nickel or cobalt complex with dil. HCl no ppt. is produced as against a black ppt. obtained from the copper complex.

Cation Generation Technique for the Identification of Cu (II) and Cd (II) at Semi-micro scale.—The chelates of copper and cadmium with Trilon B (di-sod. EDTA) on gradual treatment with $0.5 M$ aqueous PTC result in the gradual development of red colour due to copper and a compact orange-coloured ppt. of $CdCS_3$ from ammoniacal solutions. Corresponding chelates of Ni (II) and Co (II) are masked against PTC and hence create no interference.

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Department of Chemistry,   KIRPAL SINGH.
University of Delhi,
Delhi-7, *November 30, 1964.*

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LUTEOLIN AS A CHARACTERISTIC FLAVONE OF *ACANTHACEAE*

IN recent years plant phenolics and their glycosides have assumed some importance from the point of view of biochemical systematics[1] and the usefulness of chemistry in plant taxonomy as illustrated by the flavonoid constituents has also been discussed.[2] Myricetin has been recorded as a characteristic flavonol of *Hamamelidaceæ* and *Anacardiaceæ*[3] and arbutin and hydroquinone of *Proteaceæ* and possibly *Pyrolaceæ*.[4] Since the members of the *Acanthaceæ* family do not seem to have been studied in any detail for their flavonoids, we have chemically examined eleven members of this family growing in and around Pondicherry for their flavonoids and our results are summarised in Table I.

TABLE I

	Plant	Part examined	Flavone
1.	*Rungia repens*	Flowers and leaves	Luteolin
2.	*Thunbergia grandiflora*	,,	,,
3.	*Adhatoda vasica*	,,	,,
4.	*Asteracantha longifolia*	,,	,,
5.	*Ruellia tuberosa*	,,	,,
6.	*Barleria strigosa*	,	,,
7.	*B. cristata*	,,	,,
8.	*Justicia gendarussa*	,,	,,
9.	*J. pr. strata*	,,	,,
10.	*Andrographis paniculata*	Leaves	,,
11.	*Thunbergia erecta*	.,	,,

Luteolin has been isolated and identified from the flowers of *Rungia repens*,[5] *Thunbergia grandiflora* and *Adathoda vasica* and in others the occurrence of the flavone established by means of paper chromatography and comparison with an authentic sample of the pigment. The flowers of *T. grandiflora* have been found to contain appreciable amounts of iron also,

It is of special interest to note that luteolin has been found to occur in all of them which may be taken as a characteristic flavone of this family and that none of them contained detectable quantities of any leucoanthocyanidin or flavonol. The absence of leucoanthocyanidin in this family had also been recorded earlier.[6] Here. it may also be quoted[1] that many of the plants belonging to the Ranales and Rhoeadales do not produce flavonols as they lack leuco-anthocyanins.

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Jawaharlal Institute   A. G. R. NAIR.
   of Postgraduate   S. NAGARAJAN.
   Medical Education   S. SANKARA SUBRAMANIAN,
    and Research and
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SALICYLALDEHYDE AS A CHELATING AND EXTRACTING AGENT: DETECTION OF VANADIUM (V) AND ALCOHOLS

AN interesting observation is made that salicyl-aldehyde gives a stable blue-violet colour with vanadium (V) in the organic phase at pH 1·4, although at high acidities only a transitory blue colour is formed and that too in the aqueous phase. The blue-violet colour turns intense red in the presence of an alcohol, which is found to serve as a sensitive test both for vanadium (V) and alcohols. Cerium (IV), molybdenum (VI) and uranium (VI) also are found to extract into salicylaldehyde under the same or slightly different conditions.

As salicylaldehyde is sparingly miscible with water and is in itself a chelating agent, it promises to serve as a new extracting agent for vanadium and such other elements as mentioned above. Preliminary investigations showed that immiscible alcohols like *n*-butanol exert a marked synergic effect on the extraction of vanadium (V) into salicylaldehyde. The quantitative aspect of the extraction of these elements into salicylaldehyde is under investiga-tion.

We are describing below the spot tests for vanadium and alcohols using salicylaldehyde.

REAGENTS

(1) Pure salicylaldehyde,
(2) *n*-Butanol,
(3) Sodium acetate-hydrochloric acid buffer of pH 1·42,
(4) Ammonium vanadate solution,
(5) The reagent for alcohols is prepared as follows : 2·0 ml. of 0·01 N. ammonium vanadate solution is mixed with 3·0 ml. of sodium acetate-hydrochloric acid buffer of pH 1·42 in a 50 ml. separatory funnel and extracted with 5·0 ml. of salicylaldehyde for one minute. The organic layer is collected in a dry test-tube. This solu-tion is used as the reagent for the detection of alcohols.

TEST FOR VANADIUM (V)

Procedure.—To 0·2 ml. of buffer solution of pH 1·42 (which is found to be most satisfactory pH for the test) taken in a micro test-tube, 0·05 ml. of ammonium vanadate solution and 0·25 ml. of 4 : 1 mixture of salicylaldehyde and *n*-butanol are added and the contents are shaken for one minute. A red colour appearing in the organic phase indicates the presence of vanadium.

The limit of identification is found to be 0·25 μg. of vanadium and the dilution limit is 1 : 1,000,000.

Interference.—Al (III), Ba (II) Be (II), Cd (II), Ce (III), Cr (III), Cr (VI), Cu (II), Co (II), Fe (III), Pb (II), Mn (II), Mg (II), Hg (II), Ni (II), Th (IV), U (VI) and V (IV) do not interfere with the detection of vanadium (V) even at 1,000-fold concentration. Mo (VI) and W (VI) inhibit the colour formation in the organic phase. Ce (IV) also gives red colour in the organic phase under the experimental con-ditions, but the interference from Mo (VI), W (VI) and Ce (IV) can be eliminated by adding citric acid. Complexing agents like fluoride, phosphate, tartrate do not interfere, whereas oxalate and EDTA interfere even at low concentrations.

TEST FOR ALCOHOLS

Acetonitrile is used as the inert solvent for the dilution of alcohols. Common solvents like benzene, carbon terachloride, chloroform, etc., do not give clear solutions with salicylaldehyde and so are not satisfactory as diluents.

Procedure.—In a micro test-tube 0·05 ml. of the vanadium (V)-salicylaldehyde reagent solu-

tion is mixed with 0·05 ml. of solution of alcohol and thoroughly shaken. The formation of the red colour indicates the presence of alcohol.

The limit of identification and dilution limit of some alcohols tested are summarised in Table I.

TABLE I

Limits of identification and dilution limits of some alcohols

Alcohol	Limit of identification (in $\mu g.$)	Dilution limit
Methanol	39·8	1 : 2013
Ethanol	41·6	1 : 2104
n Propanol	40·4	1 : 2475
iso Propanol	39·5	1 : 2531
n-Butanol	40·7	1 : 2157
iso-Butanol	81·7	1 : 1224
sec Butanol	80·8	1 : 1238
tert Butanol	394·4	1 : 254
n-Amylalcohol	81·4	1 : 1228
iso-Amylalcohol	81·3	1 : 1230
Cyclohexanol	96·8	1 : 1033
Benzylalcohol	262·5	1 : 381
n-Heptanol	82·2	1 : 1216
1-Octanol	82·6	1 : 1211
2-Octanol	163·9	1 : 610
Ethylene glycol	55·9	1 : 1786
Propylene glycol	51·9	1 : 1927
Ethylene glycol mono-ethyl ether	46·5	1 : 2150
Diethylene glycol mono-methyl ether	103·5	1 : 966
Diacetone alcohol	465·3	1 : 215
Glycerol	630·5	1 : 159

Alcohols like sorbitol and mannitol which are insoluble in organic solvents do not respond to the test. The interference of other organic substances with this colour reaction are found to be the same as already described using sulphosalicylic acid[1] and acetylacetone[2] as ligands.

The reaction of alcohols with vanadium (V) complexes to produce the characteristic red products seems to be rather specific in view of this and similar observations made earlier.[3,4-5]

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Chemistry Department,   N. KURMAIAH.
Andhra Univ. Colleges,   D. SATYANARAYANA.
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AEROMONAS PUNCTATA IN PUNTIUS SPECIES

IN the course of a comparative study of fishes in a reservoir and in a tank which receives sewage effluent, it was of interest to observe the occurrence in large numbers of the bacterial genus, *Aeromonas*, in the fish *Puntius* species caught repeatedly from both the waters which are separated by a distance of about 26 miles on the north-western and south-eastern sides of Bangalore. While it is known that members of this bacterial genus occur in water and fish, specially as fish pathogens,[1] there seems to be no record of their presence in large numbers in association with healthy fish. For this reason the taxonomy of the numerous proteolytic aerogenic bacteria observed in the gut of *Puntius* species was studied and the results are given below.

The fish specimens were collected on three different occasions from the reservoir and the tank, using drag nets. Care was taken to avoid extraneous bacterial contamination after obtaining the catch, the specimens being stored in ice during the period before examination, which usually did not exceed 4 hours. All manipulations were done under aseptic conditions.

Suspensions of scales and gut contents, prepared in sterile distilled water, were plated on nutrient agar. After incubation for 4 days at room temperature (25–30° C.), well-separated colonies were picked out and tested for their ability to ferment (acid + gas) glucose and hydrolyse gelatin. A few isolates selected at random were examined according to methods given in the "Manual"[2] and identified on the basis of the recommendations of Eddy[3,4] and Eddy and Carpenter.[5]

A total of 73 and 80 isolations were made from the scales and gut respectively. Of these 20 and 66 respectively were found to be aerogenic and at the same time able to hydrolyse gelatin. The 8 isolates taken for detailed study could be described as follows : Gram-negative rods with polar flagella capable of fermenting glucose, mannose, galactose, fructose, sucrose, maltose, dextrin, glycerol, mannitol and trehalose with the production of acid and gas. Two strains only attacked arabinose to form acid and gas. Only slight acidity, but no gas, was produced from lactose by 6 strains and from sorbitol by 3 strains. None of the isolates fermented xylose, sorbose, rhamnose, raffinose or inositol. All the strains could hydrolyse starch, casein, gelatin and tributyrin, produce indole

and H.,S and reduce nitrates to nitrites and were V.P. positive. They were also sensitive to streptomycin (2 μg., "Biodisc") and tetracycline (5 μg.) and could grow at 37° C. None of the strains were sensitive to penicillin (10 units), bacitracin (2 units), oleandomycin (2 μg.) and neomycin (5 μg.). They did not hydrolyse pectin and sodium alginate and were unable to fix atmospheric nitrogen. The MR test was positive for 3 strains while 5 strains could utilise citrate.

The above characteristics clearly place the fish bacteria as strains of *A. punctata* (*A. liquefaciens*) as defined by Eddy[3,4] and Eddy and Carpenter[5] and suggest that the association of the bacteria with the fish is not necessarily as pathogens. In this connection reference may be made to the report of Venkataraman and Sreenivasan[6] on *Paracolobactrum* species from various fresh-water fish. Their report does not include information on the flagellar pattern of the bacteria isolated, but the IMViC results and other physiological activities, especially proteolysis and their ability to hydrolyse starch, indicate that the bacteria are *Aeromonas* rather than *Paracolobactrum* species.

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Fermentation Tech. Lab. and   F. F. DIAS.
    Dept. of Biochemistry,   A. D. AGATE.
Indian Institute of Science,   J. V. BHAT.
Bangalore-12,   S. C. PILLAI.

Dept. of Fisheries,   N. V. ASWATHANARAYANA.*
Govt. of Mysore,
Bangalore-12.
December 18, 1964.

* C.S.I.R. Scientists Pool.

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NOTE ON THE STROMATOLITES AND PROBABLE CORRELATION OF THE BHAGAWANPURA LIMESTONE, CHITTORGARH DISTRICT, RAJASTHAN

SILICEOUS dolomite, with intercalations of shale or sandstone and bands of chert, occurring between milestones 65 and 65/3 and again between milestones 66/1·5 and 66/6 along the Udaipur-Chittorgarh road had been mapped by Heron as Bhagawanpura Limestone of Precambrian-Raialo series. During the recent examination of the area, stromatolites have been observed in these dolomites. The outcrops just south of milestone 65/3 and north of 66/2 are a veritable museum of such algal structures.

Algal bedding or 'weedia' in the form of parallel or slightly arched lamellæ occur over a thickness of 2 cm. or 3 cm. The individual arches are sometimes 15 cm. across. The lamellæ are smooth and mammillary growths are seen on these in thin sections. The space in between the lamellæ is filled with silt and between one set of 'weedia' and the next, a layer of sand intervenes.

Cylindroidal columns with convex lamellæ are spectacularly developed. These are 3 cm. to 5 cm. wide at the base but expand up to 6 cm. at the top. The height of the columns vary from 12 cm. to 25 cm. and they are vertical or slightly inclined to the bedding. The section at the top is ovoidal or like that of an elongated bean 9 cm. to 18 cm. across. The lamellæ are smooth and very fine crenulations are seen in thin sections. Fine sand is seen in between the lamellæ and coarser sand occupies the space in between the columns. These forms resemble *Collenia frequens* of Richard Rezak. At places, the columns have a pair of digitations and such gymnosolen stromatolites are not common.

Some forms commence their growth from a point on the substratum and grow upwards by addition of convex lamellæ, which are flattened at the upper surface. The lamellæ of these are smooth or very finely crenulate. Some of these forms are 15 cm. high. These turbinate forms occur in between the columnar types and closely resemble *Cryptozoon accidentale* of Rezak.

Broken pieces of the columns and smaller cauliflower-like growths are also seen in the sandy layers at places.

Associated with the dolomite are bands of chert having cylindrical structures composed of laminæ in the form of inverted cones. These cones are attached to the substratum at the apex and the axes of these are at an angle to the bed-

ding. Some of the cones are 30 cm. high and the diameter of the circular base is about 20 cm. The cones are released after weathering and are found in the debris. These forms resemble *Conophyton inclinatum* of Rezak.

The Bhagawanpura Limestone has been mapped for nearly 60 km. further southwards and circular markings have been reported by Heron from near Angoria (24° 42' : 74° 35') and Utalkhera (24° 34' : 74° 33'). However, he considered them to be of inorganic origin. The structures described now from near Chittorgarh clearly indicate their algal origin.

Heron correlated with diffidence these dolomites with the generally metamorphosed and recrystallised Raialo rocks on chemical similarity and thickness. Pascoe also considered this correlation as doubtful.
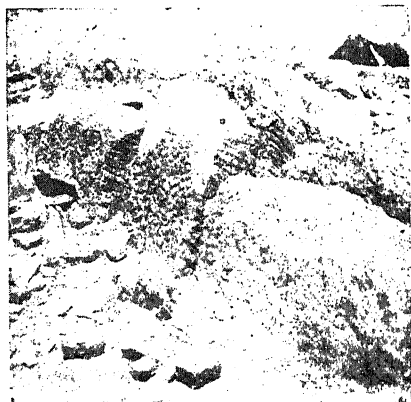
FIG. 1. Stromatolites in Bhagwanpura Limestones.

The Bhagawanpura Limestone is found in between or east of a series of fault ridges. It is overlain by variegated shales, grits and porcellanite beds (Sawa grits and Sawa shales), which Heron considered to belong to Delhi System. These unmetamorphosed formations run parallel to other undoubted Vindhyan rocks occurring further east. The stromatolites now described resemble those recorded from Vindhyan rocks of Son Valley. The conglomerate exposed in a well at milestone 63/5 has been added to the sequence which has considerable resemblance to the Lower Vindhyan rocks. The location of the Great Boundary Fault of Rajputana separating the Vindhyan rocks from the Precambrian rocks has been shown in a highly covered area on the basis of some steep dips noticed in shales. This fault has now to be shifted westwards by 4·5 km. to the area where a series of ridges of fault rock occur indicating the limit of the unmetamor-

phosed rocks against the Aravalli phyllites. These evidences indicate that the Bhagawanpura Limestone is a basal member of the Lower Vindhyans.

The authors express their thanks to Shri S. M. Mathur, Geological Survey of India, for confirming the identification of stromatolites and indicating the branching types.

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NOTE ON THE OCCURRENCE OF ZONED PYROXENE IN OLIVINE-GABBRO

MONOCLINIC pyroxenes showing compositional zoning are present frequently in the olivine-gabbro which occurs about 5 miles south of Sukinda in the Dhenkanal District, Orissa, India (exact location, 85° 56' E. : 20° 56' N.). It is a differentiated intrusive suite of basic rock complex ranging in composition from peridotite to granophyre with olivine-gabbro, norite, and anorthosite as the intermediate varieties. Olivine, labradorite, diopsidic augite, and a little hypersthene are the essential mineral constituents of the olivine-gabbro. The minerals are fresh and show medium to coarse-grained subophitic texture with olivine as the earliest formed mineral. Hypersthene grains are unzoned and show colourless to pinkish pleochroism. $2Vx$ has been measured to be 76°.

Diopsidic augite forms nearly 50% of the olivine-gabbro by volume. It is colourless or pale greenish in thin section, non-pleochroic, and prismatic in habit. $Z \wedge C = 40°$ (maximum) and $2Vz = 58°$. Birefringence is medium. Both simple and lamellar twinning are common. A good number of grains show zonal arrangement (Fig. 1) under crossed nicols. The colour is

the same, but both refractive index and birefringence of the rim are a little higher than in the core, and they also extinguish at different positions though their cleavages are sometimes sub-parallel. Exact extinction angle ($Z \wedge C = 45°$) of the rim has been measured only in one grain, all other grains showing abnormally low extinction angles. Both the core and the rim are optically biaxial positive. 2Vz of the core and the rim has been measured to be 60° and 56° respectively. The contact between the core and rim is very sharp and does not show replacement relation. Twinning is absent in these grains. In a few zoned pyroxene grains the core is clouded with very small magnetite inclusions.
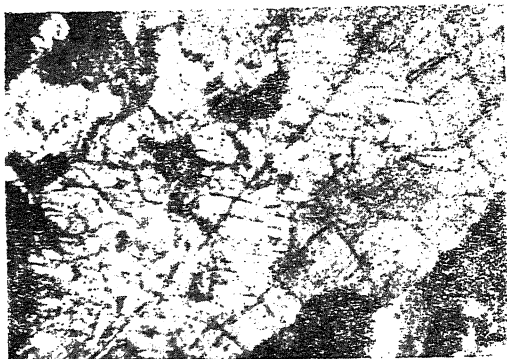
FIG. 1. Zoning in monoclinic pyroxene (under-crossed nicols), × 80.

The minor variation in optical properties shows that this is a normal case of compositional zoning. It is generally agreed that normal zoning in pyroxenes of igneous rocks is produced by non-reaction, incomplete reaction, or substitution of ions between melt and crystals during the crystallisation of mixed crystal series under conditions of rapid cooling at relatively high temperatures. The rim is evidently enriched in iron compared to the core which is more calcic or magnesia-rich. This accords with the fact that the crystallisation of olivine and pyroxene from a basic magma normally leads to enrichment of the residual liquid in iron as compared with both magnesium and calcium, e.g., in monoclinic pyroxene in the differentiated basic magma of the Skaergaard intrusion in which it has crystallised later (Wager and Deer, 1939; Muir, 1951; Brown, 1957). Kuno (1955) reported clinopyroxenes zoned from subcalcic augite to pigeonite from the volcanic rocks of Izo-Hakone province, Japan. Also, in the crystallisation of

the series $CaFe Si_2O_6$-$Fe SiO_3$ the residual melt is enriched in iron relative to calcium. There is, however, some uncertainty concerning the accurate identification of the zoned pyroxenes. The idea of rapid cooling to form zoning in pyroxene is difficult to reconcile with the present finding. Olivine-gabbro crystallises under hypabyssal to plutonic conditions where the rate of cooling is intermediate or slow, and it is obvious that the zoned pyroxenes crystallised under these conditions.

Department of Geol. Sci.,   K. L. CHAKRABORTY.
Jadavpur University,   P. B. TARON.
Calcutta-32, India,
September 24, 1964.

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INDOPHYTON—A NEW STROMATOLITE FORM GENUS *

PECULIAR spheroidal structures found in the Fawn Limestone, Vindhyan System, of the Mirzapur District, U.P., were considered by Auden[1] as formed by weathering, but Mathur et al.[2] found that they really are stromatolites and identified them provisionally as *Cryptozoon*. A restudy, however, by the present author has shown that they actually belong to the form *Collenia*. *Collenia* has also been reported by Misra and Awasthi[3] in the Vindhyan System from the Bhander Limestone in the Maihar area, M.P. Recent surveys have shown that stromatolites are widespread in the Fawn Limestone of the Son Valley, and a new form genus, named *Indophyton*, has been identified.

Indophyton is cylindrical in shape, with annular tubes forming the body, unlike most other stromatolites which are layered like a stack of variously curved or crinkled laminæ arranged in a column. The annular layers that make up *Indophyton* are composed of carbonate and chert. Some layers of the carbonate are coarse-grained, while others are composed of a fine calcilutite. Differential weathering of these various layers on the top surface gives *Indophyton* the characteristically "exfoliated"

look which identifies it from other stromatolites in the field (Fig. 1). No cell structure can be

FIG. 1

recognised or identified under the microscope. The cylinders are 18 to 45 cm. in length and 5 to 15 cm. in diameter. They are not straight but are slightly curved or bent, and show a little tapering towards the top. The *Indophyton* seems to have been formed in the same way as a tree adds annular layers to its stem. Some specimens that are eroded longitudinally look markedly like partially eaten fossil tree stems (Fig. 2).

This stromatolite is distributed over a wide area in the Fawn Limestone formation. The typical occurrence is in Salkhan Hill, Mirzapur District. Only two strata of this limestone here are stromatolite-bearing. *Indophyton* occurs as separate "stems" irregularly distributed in the strata, being disposed roughly in vertical positions. Many do not extend for the entire thickness of the strata and may not reach their top.

The author considers that it is inadvisable to give specific names to stromatolites, since internal cell structure and morphological features that may serve to characterise different species are absent. Moreover, they are not true fossils of algæ but are produced by the lime secreted by them. They are more in the nature of sedimentary structures, and it is desirable only to refer to each type as a form genus on the basis of its outer shape only, italicising and capitalising the name to indicate its organic origin. It has not, therefore, been considered proper to further classify *Indophyton* into species, or to give a specific name to the type specimens.

FIG. 2

I wish to thank my colleague Mr. C. Tripathi for helping me in naming this new form.

Northern Region,   S. M. MATHUR.
Geological Survey of India,
Lucknow, *September* 16, 1964.

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EPIDOTE TWIN FROM THE EPIDOTE-BIOTITE-SCHIST OF SYDAPURAM, NELLORE DIST., ANDHRA PRADESH

IN the course of an intensive study of the Dharwar Group of rocks of Sydapuram, Nellore District, a very interesting micro-section of biotite schist was examined under the microscope. This section contained approximately 30% of biotite, 50% of quartz and feldspar and apart from biotite, 20% of an unknown ferromagnesian mineral, which apparently looked like diopside. On a thorough examination of the optical properties of this mineral under the Four Axes Universal Stage, the mineral was found to be a normal epidote exhibiting *no* pleochroism. As one distinguishing property of the common epidote is strong pleochroism, the lack of this property itself makes this variety a noteworthy one.

On further examination, one of the epidote grains was found to be twinned. Though this feature is regarded a common one in a few well-known text-books,[1-3] a careful perusal of the published geological literature in India shows no reference to such occurrences.

Two of the refractive indices of the epidote were determined by the immersion method using the Abbe refractometer. The value of Z could not be determined at present owing to non-availability of liquids of high refractive indices. The observed optical properties of the mineral are given below :

X—1·732 ; Y—1·7495 ; Optically negative ; 2V—76° in one individual and 76½° in the other. Y was common to both the individuals and all the four optic axes could be easily made out. The extinction angle in the one individual was $X \wedge C = 4°$ and in the other $X \wedge C = 3°$. The cleavage was parallel to (100). The composition plane was (100).

From the above properties plotted in the Stereogram (Fig. 1), the Twinning Plane was made out to be (100) or the Twinning Axis the c-axis.

The optical properties made out in the Universal Stage are plotted in the Stereogram. A microphoto (Fig. 2) of the twin crystal under crossed nicols is also given.
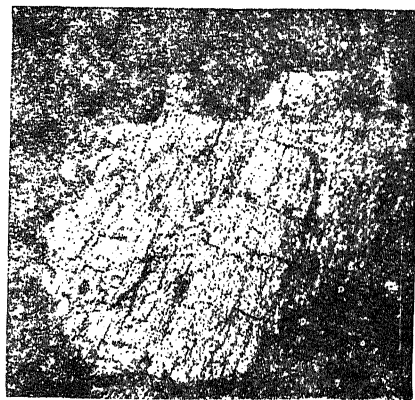
FIG. 2. Microphoto of Epidote under crossed nicols showing the composition plane and cleavage, × 50.

The author is thankful to Professor P. G. Dowie for general guidance and to the University Grants Commission for a Research Fellowship.

Department of Geology,   S. SUBRAMANIAN.
Presidency College, Madras,
September 29, 1964.

⊙ ······· x
┼ ······· y
△ ···· ·z
⊡ ···· ·b optic axis·
 ᴐ ····Pole of Composition Face
ℓ·· ····ℓ- axis·

FIG. 1. Stereogram showing the optical properties of Epidote from Sydapuram, Nellore District.

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REPRODUCTIVE CYCLE OF *OREASTER* (*PENTACEROS*) *HEDEMANNI* IN RELATION TO CHEMICAL COMPOSITION OF GONADS

PREVIOUS studies on the reproductive cycles of Asteroids indicate that in temperate regions species like *Pisaster ochraceus, P. brevispinus* and *P. giganteus* show a periodicity (Farman-farmaian et al.[1]; Giese[2]) although an exception to this feature has been reported in *Patiria miniata* which has been observed to breed throughout the year.[1] These authors have suggested that factors such as nutritional state of the animal and temperature of the environment may have an influence on breeding of these animals. It is known that in tropical regions where seasonal changes in temperature are not marked, breeding in a number of invertebrates has been shown to be continuous (Paul[3]). In the light of these observations it is of interest to note in a species of *Oreaster* (*Pentaceros*) found in Mandapam, South India, a periodicity in the reproductive cycles.

For determination of the stages of maturity of the gonads (given in Tables I and II) the method adopted is a modification of the procedure followed by Farmanfarmaian et al.[1] in which the weight of gonads in relation to total weight of the animal is expressed as 'gonad index'. The gonad index is low in starfish examined in May when gametogenic activity was just commencing. The maximum values are observed in starfish collected in October when the gonads were mature. From December the gonad index shows a fall coinciding with spent condition of gonads after which it remains low till February (Table I and Fig. 1). Both sexes show similar trends.

TABLE I

Showing the mean gonad indices and lipid content of gonads of O. hedemanni during the annual reproductive cycle

Months	Stages indicating gonadial condition of starfish	Mean gonad index of males	Mean lipid content of testes (% dry wt.)	Mean gonad index of females	Mean lipid content of ovaries (% dry wt.)
1963					
May	Immature	0·325	6·5	0·71	7·33
June	,,	0·58	23·37	0·95	20·72
July	Maturing	1·29	17·03	1·60	16·66
August	,,	1·48	24·93	2·29	18·52
October	Mature	3·80	7·32	3·43	7·65
December	Spawning	3·74	7·76	2·87	13·67
1964					
February	Spent	0·23	17·76	..	..
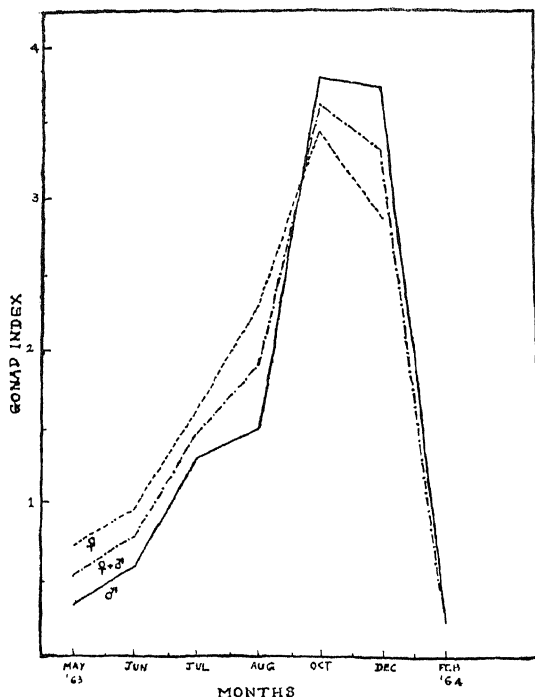
FIG. 1. Showing the seasonal variations in gonad indices in *Oreaster hedemanni* during the annual reproductive cycle during 1963 64.

TABLE II

Showing the mean hepatic indices and lipid content of pyloric cœcæ of O. hedemanni during the annual reproductive cycle

Months	Stages indicating gonadial condition of starfish	Mean hepatic index of males	Mean lipid content of pyloric cæcæ (% dry wt.)	Mean hepatic index of females	Mean lipid content of pyloric cæcæ (% drywt.)
1963					
May	Immature	4·55	27·00	6·22	31·13
June	,,	4·35	25·46	5·73	38·39
July	Maturing	3·99	32·76	4·58	29·26
August	,,	4·24	32·29	3·84	30·63
October	Mature	3·16	22·03	3·82	17·67
December	Spawning	5·73	24·98	3·25	27·15
1964					
February	Spent	5·92	39·04	..	..

Greenfield et al.[4] correlated changes in the gonadial condition with variations in the chemical composition of gonads. They observed in *Pisaster ochraceus* that lipids of the gonads show significant quantitative changes correlated with the stages of maturation. A study of the chemical composition with reference to lipids of

the gonads of *O. hedemanni* indicates marked changes which recall the results obtained by Greenfield *et al.*[4] The lipids estimated by extraction with ethyl ether were found to show a steady increase from the immature state onwards reaching the maximum in maturing condition after which there is seen a fall (Table I). During this period the pyloric cæcæ were observed to decrease in size in both sexes as inferred from a fall in 'hepatic index'. This was calculated following the method of Farmanfarmaian *et al.*[1] in which the weight of pyloric cæcæ in relation to the total weight of the animal is expressed as 'hepatic index'. Table II shows a correlation between hepatic index and the stages in maturation of the gonads. The lipid content of the pyloric cæcæ shows a significant fall when the gonads are fully ripe as has been noted in *P. ochraceus.*[4] A rise in the lipid content of the pyloric cæcæ when the gonads are in a spent condition may be indicative of fresh accumulation of lipids and their non-utilization by the gonads at that period.

The results reported above may suggest a close relation between the nutritional state of the animal and breeding cycles. This is reflected in the relative lipid content of the gonads and the pyloric cæcæ in different stages of the gonadial cycle. The above suggestion is in conformity with the views of Greenfield *et al.*[4]

The author expresses his sincere thanks to Professor G. Krishnan for valuable guidance and criticism. The author is grateful to the University of Madras and the C.S.I.R., New Delhi, for financial support.

University Zoological   K. SATYANARAYANA RAO.
   Research Laboratory,
Chepauk, Madras-5,
September 7, 1964.

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ELLISIELLA CAUDATA (PK.) SACC.— A NEW RECORD TO INDIA

DURING the rainy season (August-September) of 1963, the writer noticed several plants of *Cymbopogon martinii* Stapf. (Graminæ) growing in the grasslands at Khandala (elevation 677 m.) showing folicular infection in the form of black lenticular fungus tufts on the dead and dying leaves which, on microscopic examination, revealed the presence of sporodochia-like fruiting bodies intermingled with stiff brown setæ. This fungus at first sight appeared like a species of *Colletotrichum.* A close study, however, showed that the fungus produced fusiod conidia with a single apical filiform appendage, and was identified as a species of *Ellisiella* Sacc. A further detailed comparative study showed it to be *Ellisiella caudata* (PK) Sacc.

FIG. 1. (A) Sporodochium. (B) Conidia.

The genus was established by Saccardo (1881) with *E. caudata* as type collected from U.S.A. on dead stems of *Andropogon furcatus* Muhl. According to Sprague the fungus was originally described as a *Colletotrichum* by Peck (1885) who considered the conidial appendages as pedicels and the sporodochia as acervuli characteristic of the Melanchoniales. In view, however, of its distinctive morphological characters particularly in having appendaged conidia produced on a basal layer of conidiophores, the fungus is moniliaceous and not melanchoniaceous and the conidial appendages are apical and not basal as was previously considered by Peck (1885).

The following is a brief description of the fungus :

Ellisiella caudata (PK) SACC.

Michelia 2, 26, 1881.

Infection spots (sporodochia) in tufts, erumpent, oblong to sub-linear or lenticular, scattered, 100–240 μ.

Setæ (sterile hyphæ) rigid, erect, septate (1 to 3), simple, cuspidate, dark brown, bulbous at base, 5 to 13 generally 9 per sporodochium, 45–148 μ long.

Conidiophores in basal layers, sub-pyriform, sub-hyaline, simple, 8–18 × 2–5 μ.

Conidia fusoid slightly curved, hyaline, 1-celled, with a single hyaline, filiform apical appendage, 10–30 × 2–4 μ.

On dead leaves of *Cymbopogon martini* Stapf. (*Rosha gavat*) collected by P. G. Patwardhan, August-September 1963, at Khandala, India.

The fungus genus is a new addition to the fungi of India and *Cymbopogon martinii* Stapf. a new host record for *E. caudata* (PK) Sacc.

Grateful thanks are due to Prof. M. N. Kamat for his guidance and to the Director, for laboratory facilities.

M.A.C.S. Laboratory,   P. G. PATWARDHAN.
Poona-4, *March* 28, 1964.

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OCCURRENCE OF *ERYSIPHE GRAMINIS* VAR. *TRITICEI* IN BOMBAY—MAHARASHTRA

DURING December 1963 the writers noticed several cultures of wheat growing in the Nursery of Wheat Research Station at Mahabaleshwar (elevation 4,500 ft.) affected by a powdery mildew. The disease was of moderate intensity and was specially found at the 'boot stage' in the *Durum* as well as 'Vulgare' varieties obtained from Gujarat grown in the experimental plots. The prolonged cool weather prevailing during the growing season appeared to favour development of this mildew which was found only in the oidial stage. A careful search for the perithecial stage was made without success.
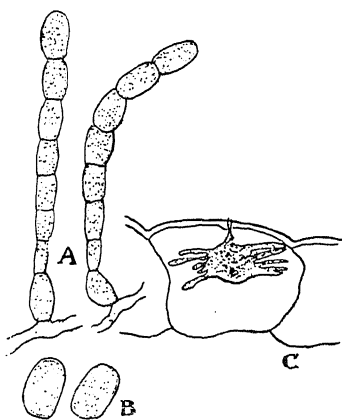
FIG. 1. A. Conidiophores with bulbous base, × 70. B. Conidia, × 70. C. Haustorium in the epidermal cell, × 230.

The mildew affecting the stems and leaves was critically examined in sections, which revealed the presence of an ectophytic creeping mycelium sending forked haustoria into the epidermal cells and producing vertical conidiophores with a characteristic bulbous base and bearing typically oval hyaline conidia in long persistent chains. Conidia measured 18–40 × 9–19 μ. No appreciable effect was noticed in the affected plants in respect of yield.

On the basis of the distinctive conidial characters the mildew was identified as *Erysiphe graminis* f. *triticei* Marchal. The mildew is a new report to this state.

Wheat Research Station,   W. Y. GADRE.
Mahabaleshwar and   P. G. PATWARDHAN.
    M.A.C.S. Laboratory,
Poona-4, *March* 28, 1964.

A NEW DISEASE OF CORIANDER CAUSED BY *COLLETOTRICHUM CAPSICI* (SYD.) BUTLER AND BISBY FROM INDIA

A SERIOUS disease of coriander (*Coriandrum sativum* L.) caused by *Colletotrichum capsici* has recently been observed. The disease manifests mainly on the inflorescence and is characterised at the time of flowering. In the beginning young pedicels, at the juncture of flowers, are infected, they become pale and droop. The disease rapidly spreads and in most cases, flowers do not open and are killed. The disease also extends downwards thereby killing the whole inflorescence and in severe cases leaves also. In such cases seeds are not formed and the inflorescence appears blighted. In cases where infection comes late, undeveloped and shrivelled seeds may be formed. In still other cases, it is not uncommon to find completely blighted and healthy seeds in one and the same inflorescence.

Pathogenicity tests were carried out before flowering and after flowering by spraying spore suspension from 15 days old culture. Symptoms appeared after 12 days of inoculation in the latter case and only on inflorescence which later on extended to the adjacent leaves.

The mycelium is inter- and intracellular and does not form haustoria. The fungus forms acervuli in abundance on potato-dextrose agar. The acervuli measure 332·0 μ on an average, and the setæ 52·5–270·0 μ. Conidia are single-celled, fulcate, vacuolated, hyaline and measure 20·6–31·6 × 3·7 μ. The fungus has been identified as *Colletotrichum capsici* (Syd.) Butler and Bisby. This appears to be a first record of the fungus on *Coriandrum sativum*. L.

Sincere thanks are due to Mr. Suttan and Dr. J. C. F. Hopkins of C.M.I., for confirming

the identification, to Dr. R. L. Mathur, Plant Pathologist, Rajasthan, for kind interest in work and to Shri T. C. Kala, Director of Agriculture, Rajasthan, for facilities.

Plant Pathology   S. P. SEHGAL.
    Section   A. L. DESHPANDE.
Sub-station, Kota   U. S. SHRIVASTAVA.
(Rajasthan), *June 25, 1964.*

GYROTHRIX CIRCINATA (BERK. AND CURT.) HUGHES, A NEW RECORD FOR INDIA

In the course of his studies on the mycoflora of Bhopal (India), the author collected *Gyrothrix circinata*, a hyphomycetous fungus on dead portions of living leaves of *Syzygium cumini* (Linn.) Skeels, from Botanical Garden, Motilal Vigyan Mahavidyalaya, Bhopal, on 12th September 1963. *Gyrothrix circinata* has been recorded from North America, Indonesia, and Africa ; here it is being presented as a new record for India.

Colonies effused, velvety, dark brown to black, 0·5–2 mm. diam., chiefly hypophyllous, scattered. Mycelium superficial, composed of a network of branched and anastomosing, smooth-walled, septate, subhyaline to light brown hyphæ bearing closely packed sporogenous cells, here and there becoming thickened and dark brown at the point of origin of the setæ. Setæ (Fig. 1)

numerous, intertwined, erect, thick-walled, septate, dark brown, spinulose, circinate, 2–4 times branched, 70–120 μ high, 4–5 μ broad at the base (above the bulbous swelling) tapering to a width of 1 μ at the apices of the branches. Branching sub-dichotomous, branches paler in colour, markedly spinulose, circinate. Sporogenous cells (Figs. 2–3) borne laterally on the superficial hyphæ, obclavate to lageniform, pointed above, sub-hyaline, 6·4–8 μ high, 3–4·8 μ wide at the base. Conidia adherent, aggregated into a whitish layer at the base of setæ, cylindrical to fusoid, straight or slightly curved, with the attached end subulate and the free end bluntly corniform, continuous, hyaline, 8–13 × 1·5–2·4 μ.

The voucher specimen has been deposited in the herbarium of C.M.I., Kew, as No. 102502. The author expresses his grateful thanks to the Principal and Prof. O. N. Handoo for facilities and encouragement ; to the Director and Dr. Ellis of C.M.I., Kew, for help in identification of the fungus.

Pathology Section,   H. N. SATYA.
Department of Botany,
Motilal Vigyan Mahavidyalaya,
Bhopal, *June 27, 1964.*

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INDUCED AUTO-TETRAPLOID IN *COFFEA CANEPHORA* PIERRE EX FROEHNER

THE importance of obtaining mutations in *Coffea* by artificial means for genetical studies and breeding purposes has been stressed by Sybenga (1961). The methods so far applied are irradiation of seeds and plants to obtain point mutations (Carvalho *et al.*, 1954 ; Moh and Orbegaso, 1959) and colchicine treatment of seeds and sucker cuttings to induce chromosome doubling (Mendes 1939, 1947). Of the seven species in *Coffea* and a triploid hybrid of *C. arabica* × *C. canephora* where chromosome doubling has been reported, *C. arabica* ($2n = 44$), *C. canephora* ($2n = 22$), *C. Dewewerei* ($2n = 22$) and the triploid hybrid of *C. arabica* × *C. canephora* have been subjected to clochicine treatment (Darlington, 1955 ; Krug, 1937 ; Mendes ; 1939, 1947 ; Narasimhaswamy, 1946 ; Sybenga, 1961). Seeds wetted in sterilised soil for 30 days and treated with 0·3% colchicine have given good results in the case of the species, whereas, in the triploid hybrid and a di-haploid in *C. arabica*

FIGS. 1 3. *Gyrothrix circinata*.   Fig. 1.   Setæ.
Fig. 2. Conidiophores and conidia.   Fig. 3.   Hyphæ and conidiophores in top view. (Fig. 1 to scale B ; Figs. 2–3 to scale A).

sucker cuttings have been used for treatment with colchicine and grafts established from these. Chromosome doubling in the latter has resulted in restoration of fertility.

From literature available cytological details have so far been published in polyploids in *Coffea arabica* (Krug, 1937). The present note is a preliminary report on the morphology and cytology in a seedling of *C. canepora* in which tetraploidy was induced by colchicine treatment at Central Coffee Research Institute in 1955.

Growing shoot-tips of 4-month old seedlings from S. 274, a selection of *C. canephora* was subjected to colchicine treatment of varying concentrations and duration. Of these 0·3% concentration for 12 hours at room temperature gave successful results. The effect of colchicine was evident from the 'gigas' characters noticed after about a month from the time of treatment (Figs. 1 and 2) and 44 somatic chromosome number noticed in shoot-tip squashes.

FIGS. 1-6. Fig. 1. Normal diploid *C. amphora*, 5 months old. Fig. 2. Tetraploid induced by colchicine. Fig. 3. A twig from normal diploid, 2 years old. Fig. 4. A twig from tetraploid, 2 years old. Fig. 5. Metaphase I showing 7 iv, 2 iii; 4 ii, 2 i. Fig. 6. Anaphase I showing delayed disjunction.

Morphology.—A comparative account of vegetative and floral characteristics is given in Table I.

The tetraploid shows profuse flowering every season but the set is very low. Seeds are not as uniform in size and shape as in the diploid. Selfing by bagging during 1964 flowering season was a complete failure, 100 bulk seeds were collected for raising progeny; of this, 78 germinated and 76 seedlings are existing.

TABLE I

	Tetraploid	Diploid
1. Primaries	Acute angle with the main stem, 30-35 degrees; thicker and brittle with shorter internodes	40-45 degrees
2. Leaf ..	Thick, coarse, dark green with comparatively more wavy margin	
	Length/breadth: 20·3/15·3 cm.	17·7/10·2 cm.
	Thickness 0·37 mm. (Fig. 3)	0·27 mm. (Fig. 4)
3. Stomata ..	Length/width: 27·3/19·5 in microns	17·5-19·5 13·6-15·6
	No. per sq. mm. 184·8	267·8
4. Flowers :		
Petals and stamen	7 merous 5·7%	Nil
	6 merous 71·4%	31·8%
	5 merous 22·9%	68·2%
Petals: Length/ width	1·55/0·65 cm.	1·60/0·45 cm.
Anthers: Length/ width	1·15/0·25 cm.	1·25/0·15 cm.

Cytology.—Chromosome associations were studied at Diakinesis and Metaphase (Fig. 5). These show the following features :

	(iv)	(iii)	(ii)	(i)
Range	4-7	0-3	4-14	0-5
Mean per cell	5·75	1·5	7·42	1·18

Delayed disjunction at A.I., laggards and irregular distribution of chromosomes were occasionally observed (Fig. 6). In most cases the laggards showed equational division and moved to opposite poles in time to get included in the telophasic nuclei. Equal distribution of 22-22 chromosomes to the two poles were seen in a majority of pmcs. Occasionally monads, dyads and pentads were also found. Size of pollen grains ranged from 28-44 microns in the tetraploid as against 20-36 microns in diploids. Good pollen as determined by iodine tests was found to be 96% and 79·7% in the treated and the normal plants respectively.

In the bulk seedlings from the tetraploid, indications of diploid, tetraploid and aneuploid plants are so far noticed.

Conclusions.—The technique employed to induce tetraploidy in the shoot portion of seedlings and the subsequent growth of these with gigas characters and flowering show the success of the technique.

Highest association of chromosomes noticed was quadrivalents. The frequency of various associations show that bivalents are considerably more than the quadrivalents, and univalents and trivalents are fewer and are almost equal in number. Meiotic irregularities are also considerably very few. Similar chromosome associations and frequency and meiotic behaviour have been reported in tetraploid of species where the chromosome size is small and chiasma frequency is low (Kostob; 1940; Earnshaw; 1942 quoted by Mehta and Swaminathan, 1957). Coffee chromosomes are known to be short (1·0 to 3·3 μ) the whole complement in *Coffea* on an average measuring about 33 μ (Bouhermont, 1959) and the chiasma frequency not more than two per bivalent (Sybenga, 1961).

Sterility is common among auto-tetraploids and this has been attributed to meiotic irregularities, genetic or physiological imbalance. In the present studies lower meiotic irregularities, higher percentage of good pollen, failure to set seed by selfing appear to indicate that self-incompatibility characteristic of the species is maintained at the tetraploid level. Studies on the progeny from the bulk seed showing varying chromosome numbers, breeding behaviour of the tetraploid and further embryological studies should throw more light on this aspect.

The writers are grateful to Sri. R. L. Narasimhaswamy, Botanist, for the guidance and to Dr. N. G. Chokkanna, Director of Research, for the kind encouragement.

Botany Division,   S. Vishveshwara.
Central Coffee   C. C. Chinnappa.
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EMBRYOLOGY OF LINACEAE

The information on the embryology of the family Linaceæ is meagre. Earlier work was summarized by Schnarf (1931) and subsequently Mauritzon (1934) studied the embryology of *Radiola linoides*. In the present study the embryology of three taxa of the family, viz., *Roucheria griffithiana* Planch., *Ochthocosmus africanus* Hook. f. and *Ixonanthes icosandra* Jack. is described. Hutchinson (1959) placed the two latter taxa in a separate family, the Ixonanthaceæ under the order Malpighiales.

The anther structure shows an epidermis and four wall layers. The innermost wall layer constitutes the secretory tapetum, the cells of which become binucleate. In *Ochthocosmus africanus* and *Ixonanthes icosandra* granular thickenings develop on the inner surface of the tapetum at about the time the pollen mother cells undergo meiosis. These gradually increase in size and run into one another making the surface markedly uneven. The hypodermal wall layer develops into the endothecium in the mature anther while the middle layers become crushed during development. In *Ochthocosmus africanus* some of the epidermal cells at the line of dehiscence enlarge conspicuously and constitute the stomium (Fig. 1).
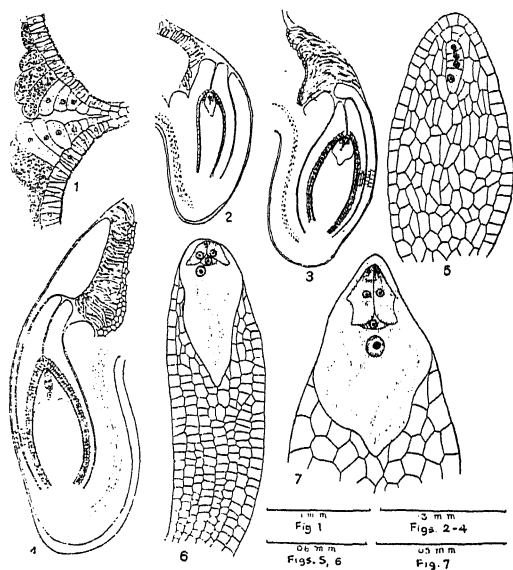
FIGS. 1–7. Figs. 1, 3, 7. *Ochtho osmus africanus*; Figs. 2, 6. *Roucheria griffithiana*; Figs. 4, 5. *Ixonanthes icosandra*. Fig. 1. Portion of anther showing the stomium. Figs. 2–4. L. S. ovules. Fig. 5. L. S. nucellus showing the linear megaspore tetrad and parietal layers. Fig. 6. L. S. nucellus (strand-like) showing the mature embryo-sac. Fig. 7. L. S. nucellus showing mature embryo-sac.

The pollen mother cells undergo usual meiotic divisions. Quadripartition of microspores is brought about by cleavage furrowing. Pollen is two-celled at the shedding stage.

The ovule is crassinucellar, bitegminal and anatropous (Figs. 2–5). A placental obturator is present in all the three taxa (Figs. 2–4). The outer integument in *Roucheria griffithiana* is shorter than the inner which alone forms the micropyle (Fig. 2). In *Ochthocosmus africanus* and *Ixonanthes icosandra* it extends above the level of the inner; in the former it becomes rounded at the apex (Fig. 3), while in the latter it becomes expanded in the form of a wing and abutts the hairy obturator (Fig. 4). The innermost layer of the inner integument develops into the endothelium, the cells of which are uninucleate (Figs. 2–4). The nucellus in *Roucheria griffithiana* is narrow and strand-like (Figs. 2, 6) while in the other two taxa it is broad and massive (Figs. 3, 4, 7). A parietal tissue of 2–5 layers is developed (Fig. 5).

The archesporium in the ovule is single-celled and hypodermal. It cuts off a primary parietal cell before it functions as the megaspore mother cell. A linear tetrad of megaspores is formed as a result of meiosis of the megaspore mother cell (Fig. 5). The lowest megaspore is functional and gives rise to an 8-nucleate embryo-sac as a result of three successive free nuclear divisions. The egg apparatus consists of two hooked synergids which show a filiform apparatus and an egg (Figs. 6, 7). The antipodals are ephemeral and the polar nuclei fuse before fertilization (Figs. 6, 7). The embryo-sac enlarges during development and crushes the parietal layers and the nucellar epidermis on the sides and above and the nucellar tissue below.

Our thanks are due to Prof. M. R. Suxena for his kind interest and encouragement, and to Dr. T. S. Bakshi and Dr. Anwari Dilmy for the materials of *Ochthocosmus* and *Ixonanthes* respectively.

Department of Botany,   D. RAO.
Osmania University,   L. L. NARAYANA.
Hyderabad-7 (A.P.), *September 28, 1964.*

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A NEW ASCOMYCETE FROM HYDERABAD—INDIA— *PARASTIGMATEA SYZYGII* SP. NOV.

THE genus *Hypostigme* was founded by Sydow[1] 1925 based on the type and only species *Hypostigme polyadelpha* collected from Costa Rica on *Buettneria carthagensis*. Arx and Mueller[2] (1954) who examined the above fungus found it to be similar to *Parastigmatea*, a genus which was earlier founded by Dodge[3] (1921) on *P. nervisita* collected from South Africa. Therefore they have renamed *Hypostigme polyadelpha* as *Parastigmatea polyadelpha* (Syd.) Arx and Mueller. On the basis of study, the fungus infecting the leaves of *Syzygium* sp. has been placed in Microthyriales-Stigmateaceae-Hyalosporae-*Parastigmatea* Dodge. The fungus under study differs from the species known so far, in the larger size of asci, ascospores and other characters, besides infecting totally a different host. Therefore it is described and presented as a new species. The type specimen is deposited at the Commonwealth Mycological Institute, Kew, England.
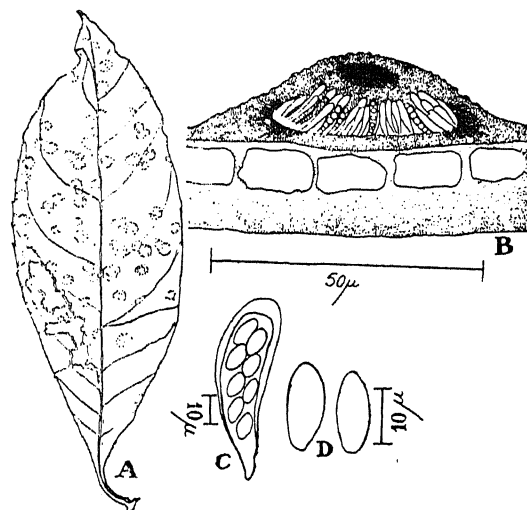
FIG. 1. (A) Infected leaf of *Syzygium* sp. (B) Cross-section of the shield-shaped stroma, showing asci. (C) Ascus with 8 spores. (D) Ascospores.

Parastigmatea syzygii SP. NOV. RAO, P. N.

Thyrothecia mostly epiphyllous, rarely amphigenous, entirely superficial forming concentric rings, 2–3 rings coalesce, 4–6 mm. in diameter. Thyrothecia dark, sub-cuticular wide with an innate hypostroma, resting on the epidermis, shield-shaped to orbicular or conic, $340 \cdot 0–544 \cdot 0 \times 85 \cdot 0–187 \cdot 0 \mu$. The upper wall is opaque, dark brown, many-layered, covered by the raised cuticle, $27 \cdot 2–51 \cdot 0 \mu$, thick, lower wall

dark olivaceous, single layered, adhering to the wall of the underlying epidermis. Asci numerous, projecting from the base, cylindric to clavate, bi-tunicate, 8-spored, apharaphysate, $67 \cdot 5$–$90 \cdot 0 \times 13 \cdot 5$–$15 \cdot 0\,\mu$. Ascospores 1–2 seriately arranged, hyaline, 1-celled, ellipsoid, rounded at the apex, smooth, $15 \cdot 0$–$19 \cdot 5 \times 6 \cdot 75$–$7 \cdot 5\,\mu$.

On the living leaves of *Syzygium* sp. (Myrtaceæ), Hyderabad, Miss-Renuka, December 1959, O.U.B. Herb. No. 176 type.

Parastigmatea syzygii SPEC. NOV. RAO, P. N.

Thyrothecia vulgo epiphylla, raro amphigena penitus superficialia efformantia circulos concentricos, quorum bini ternive coalescunt, 4–6 mm. diam. Thyrothecia fusca, subcuticularia, lata innato hypostromate ornata, quiescentia super eipdermidem, scutiformia vel orbicularia vel conica, $340 \cdot 0$–$544 \cdot 0 \times 85 \cdot 0$–$187 \cdot 0\,\mu$. Paries superior non-translucidus, fusce brunneus, multiseriatus opertus elevato cuticulo, $27 \cdot 2$–$51 \cdot 0\,\mu$ crassus. Paries inferior fusce olivaceus, uniseriatus, adhærens parieti epidermidis subjacentis. Asci plures, protrusi e basi, cylindrici vel clavati, bitunicati, octospori, aparaphysati, $67 \cdot 5$–$90 \cdot 0 \times 13 \cdot 5$–$15 \cdot 0\,\mu$. Ascosporæ 1–2 serie dispositæ, hyalinæ, unicellulares, ellipsoideæ, apice rotundo, leves, $15 \cdot 0$–$19 \cdot 5 \times 6 \cdot 75$–$7 \cdot 5\,\mu$.

In foliis vivis *Syzygii* sp. e fam. Myrtacearum, ad Hyderabad, Dna. Renuka, mense decembri 1959, O.U.B. Herb. No. 176 typus.

The author is under deep obligation to Dr. Emil Mueller, Institute of Special Botany, Zurich, Dr. F. C. Deighton, Commonwealth Mycological Institute, Kew, England, for the help in the identification of the ascomycete described. Grateful thanks are expressed to Prof. M. R. Suxena for encouragement and to Prof. H. Santapau for the Latin diagnosis.

Mycology and Plant Pathology P. N. RAO.
  Section,
Department of Botany, Osmania University,
Hyderabad-7 (A.P.), *June 22, 1964.*

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THIN LAYER CHROMATOGRAPHY OF INDOLES

THIN layer chromatography was successfully applied by MacMillan and Suter[1] for the separation of gibberellins, a group of plant growth regulators. The present investigation is attempted to find out the suitability of the above technique for the resolution of indole compounds, particularly those that are known to occur as natural constituents of plants.

Two different adsorbents, silica gel and kieselguhr, with gypsum as binder in each case were tried. Glass plates of size 26 cm. × 12 cm. were layered manually with silica gel (silica gel for adsorption chromatography and plaster of Paris were mixed in proportion of 85 : 15[2] by weight) by pouring a slurry in water on the plates and allowing it to spread through the entire plates. Usually a slight excess of slurry ($8 \cdot 0$ g. in 15 ml. water) that is just required for layering a plate is poured and it was allowed to drain off the sides of plate thus ensuring uniform thickness. Kieselguhr plates were prepared similarly using kieselguhr which was mixed with 15% by weight of plaster of Paris. The prepared plates were dried for 30 minutes at 120° C.

Three to ten microgram quantities of authentic samples of tryptophane, indole-3-acetic acid, 3-indole acetonitrile and indole in 50% alcohol were placed, individually and in mixture about $1 \cdot 0$ cm. from one end of the plate. Plates were then developed in dark in different solvent systems (*see* Table I) in an ascending direction in chambers previously saturated with the same. Development took place for 45 to 60 minutes at room temperature when most of the solvents advanced to about 24 cm. from origin.

The developed plates were dried in dark and were sprayed with Ehrlich reagent[3] to detect the indole substances. Nitrous-nitric reagent[3] was also found useful. The results are shown in Table I.

TABLE I

Rf values* of indole compounds on thin layer chromatograms

Sample	Silica gel					Kieselguhr	
	S^1	S^2	S^3	S^4	S^5	S^1	S^2
Tryptophane	0·00	0·00	0·00	0·56	0·63	0·00	0·00
Indole 3-acetic acid	0·24	0·00	0·50	0·74	0·75	0·95	0·00
3-Indole acetonitrile	0·64	0·00	0·82	0·53	0·59	0·97	0·32
Indole	0·82	0·15	0·90	0·82	0·35	0·98	0·00

S^1. Benzene : acetic acid : water (2 : 1 : 1); S^2. n-Hexane saturated with water; S^3. Chloroform : ethnaol : formic acid : water (20 : 4 : 2 : 1); S^4. Acetic acid : water (1 : 3); S^5. Water. * mean of five plates.

Of the two adsorbents used here, silica gel gave better resolution in all the solvents tested while kieselguhr did not prove as useful in this range of solvents. Among the solvent systems, benzene : acetic acid : water was most useful in separating all the four indoles. In hexane solvent indole is separated from the

rest which are immobilised with silica gel adsorbent while 3-indole acetonitrile alone moved using kieselguhr in the same solvent.

Thus a silica gel thin layer chromatography in benzene : acetic acid : water appears to be quite suitable for resolving a mixture of indoles tried here. The technique affords an obvious advantage over paper chromatography of the same compounds since the time required for development is very much shortened in this case. An adoption of this method for analysing plant extracts is under progress.

Department of Botany,   V. S. R. Das.
S.V. University,   J. V. S. Rao.
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November 17, 1964.

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ON AN UNUSUAL SWARMING OF THE PLANKTONIC BLUE-GREEN ALGAE *TRICHODESMIUM* SPP., OFF MANGALORE

INSTANCES of 'discoloured' water phenomenon in the Indian waters have been reported earlier.[1-8] This is caused by a variety of organisms such as blue-green algæ, cystoflagellates and dinoflagellates, and is sometimes associated with adverse effects on the marine fauna including fish.

In the course of experimental fishing operations in the 12 and 25 metre regions off Ullal (Mangalore) on the Mysore coast, extensive greenish-yellow patches were noticed on 13th and 21st March 1964. Analysis of the surface plankton collections from 12 and 25 metre areas revealed the presence of blooms of *Trichodesmium erythrœum* Ehrenberg ex Gomont on 13th March, and *T. hildebrantii* Gomont on 21st March, only in the latter region. On these days they were found almost to the exclusion of the other planktons as observed from a comparative study of the plankton of the two areas (Table I).

Observations on the hydrological conditions of the surface waters at the two stations revealed no significant differences, yet the algal blooms were found to be restricted to the 25 metre region only.

In order to find out the effect of the algal bloom on the inshore fishery at Ullal, the trend of the fishery during the month was followed based on the records of fish landings maintained

TABLE I
Composition of the plankton

| | | Numbers per c.c. of standardised volume of 250 c.c. | | | |
| | | 13-3-1964 | | 21-3-1964 | |
		12 metres	25 metres	12 metres	25 metres
Algae					
T. erythreum	..	Nil	1,03,000	2,600	Nil
T. hildebrantii	..	,,	2,080	Nil	75,000
T. thiebantii	..	,,	Nil	,,	5,000
Diatoms	..	9,300	130	2,700	110
Dinoflagellates	..	Nil	7	100	65
Copepods	..	1,570	12	325	115
Prawn eggs	..	600	Nil	10	Nil
Cladocerans	..	250	3	205	1
Other zooplankters	..	40	15	140	54

at this research unit. It was observed that oil sardine and mackerel were landed in good quantities during the first week of March 1964 preceding the algal bloom. Subsequently, there were no catches of either oil sardine or mackerel, which coincided with the onset of the algal bloom. However, towards the end of the month the revival of the fisheries was observed following the disappearance of the algal blooms.

It may be pointed out here that the normal fishing activity with the indigenous gears operated within the 5-8-metre area was also adversely affected even though this region was free from *Trichodesmium* patches. The occurrence of *Trichodesmium* spp. in extensive patches in the regions farther away from the shore would thus seem to have an adverse influence on the coastal fisheries.

It was also interesting to note that the stomach contents of stray catches of *Thrissocles mystax*, *Sardinella longiceps*, *S. fimbriata*, *Caranx kalla* and *Opisthopterus tardoore* made by the departmental gill net *Chalabale* at the 25-metre region did not reveal the presence of *Trichodesmium* spp. at all.

Central Marine Fish.   M. S. Prabhu.
   Research Unit,   S. Ramamurthy.
Mangalore-1 (S.K.),   M. D. K. Kuthalingam.
July 1, 1964.   M. H. Dhulkhed.

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REVIEWS

The Microscopical Characters of Artificial Inorganic Substances, Optical Properties of Artificial Minerals. By Alexander Newton and Horace Winchell. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. 439. Price $ 14.50.

All available data on optical properties of inorganic solids are presented in this book. Unique to this edition is a convenient, versatile, graphic summary of optical properties, keyed directly to the full descriptions of the substances. An important addition is the reference to readily available X-Ray Powder Data of the substances described which facilitates the joint use of powder diffraction data and optical properties, greatly speeding the work of the chemist interested in confirming an identification.

A description of the substances in this book are given in the following order : Chemical formula and name if any ; Crystal symmetry and the dimensions of the unit cell, or the axial ratios if the dimensions are unknown ; Brief data on crystal habit, cleavage, twinning, and such ; Hardness and specific gravity, and fusibility and melting point in degrees Celsius ; Optical properties, including optic orientation ; Extinction angles to prominent elongation, cleavages, or crystal faces ; Principal refractive indices for D-line of sodium and if possible for other wavelengths ; Optic sign, optic axial angle, dispersion, colour, pleochroism, and absorption. It will be obvious from these details that this work would be a highly useful work of reference to the chemist.   C. V. R.

Elementary Particle Physics. By Professor Gunnar Kallen. (Addison-Wesley Publishing Company, Inc., Massachusetts, U.S.A. and London), 1964. Pp. 546. Price $ 15.00.

This advanced graduate level book develops the field of elementary particle physics from a systematic and unified point of view. The subject is divided into the four following broad divisions, each of which having several chapters devoted to them : I. Introductory Remarks ; II. Strong Interactions of Non-strange Particles ; III. Strong Interactions of Strange Particles and IV. Weak Interactions. Considerable attention is devoted to a detailed presentation of basic methods and techniques. The student is assumed

to have a thorough knowledge not only of ordinary non-relativistic quantum mechanics but also of the Dirac equation and some knowledge—although not very much—of elementary field quantization.

This book is based on a course on phenomenological elementary particle physics given in the academic year 1961-62 by the author at the Department of Theoretical Physics at the University of Lund, Sweden. It is warmly recommended.   C. V. R.

Physical Techniques in Biological Research. Edited by William L. Nastuk. (Academic Press, Inc., 111, Fifth Avenue, New York-3.) Vol. V—Part A—*Electrophysiological Methods,* 1964. Pp. 460. Price $ 16.00 ; Vol. VI—Part B—*Electrophysiological Methods,* 1963. Pp. 425. Price $ 14.50.

These books are intended to provide the theory and broad principles of electrophysiology in addition to the specific information needed by graduate students and experienced investigators in acquiring the knowledge of physical techniques. Volume V contains the following chapters: 1. Stimulation ; 2. Microelectrodes for Recording and Stimulation ; 3. Electrodes for Extracellular Recording and Stimulation ; 4. Microelectrophoresis ; 5. Micromanipulators : Principles of Design, Operation, and Application ; 6. Transducers ; 7. Bioelectric Amplifiers ; 8. Interference and Its Elimination ; and 9. Recording and Display. Volume VI contains the following chapters : 1. Fundamentals of Digital and Analog Computers ; 2. Operational Amplifiers ; 3. Analysis of Complex Waveforms ; 4. Cable Theory ; 5. Voltage Clamp Techniques ; and 6. Determination of Biological Impedances.

These books will admirably fulfil the purposes for which they are intended and are warmly welcomed.   C. V. R.

Determination of Organic Structures by Physical Methods, Volume II. Edited by F. C. Nachod and W. D. Phillips. (Academic Press, New York and London), 1962. Pp. xii + 771. Price $ 16.00.

Volume I of this series dealt with the various methods for determining molecular size, molecular pattern and molecular fine structure. The present volume in a sense is a repetition of

these, but great advances have been made in these fields since the publication of Vol. I in 1955, and new techniques like electron spin resonance and nuclear magnetic resonance have become important. The volume under review therefore deals with these new techniques and with advances in some of the older techniques.

The first chapter deals with Optical Rotatory Dispersion and its applications to stereochemical conformations. Then follow two chapters on Mass Spectrometry and Infrared and Raman Spectroscopy, which are followed by a pair of chapters on Electronic Spectra of Polyatomic Molecules and Far Ultraviolet Spectroscopy. There are six chapters on Resonance Spectroscopy, which dominates the whole volume : NMR spectra of hydrogen and fluorine, of elements other than H and F, of organic solids, EPR of organic molecules and organometallics, Nuclear quadrupole resonance spectroscopy.

All the chapters are highly informative and the references are extensive. There is no doubt that the volume will be used as a source book by a variety of workers interested in the molecular structure of organic compounds.

G. N. RAMACHANANDRAN.

Advances in Nuclear Science and Technology, Vol. II. Edited by E. J. Henley and H. Koutz. (Academic Press, Inc., New York-3), 1964. Pp. x + 378. Price $ 14.00.

The second volume of *Advances in Nuclear Science and Technology* presents a collection of the following six articles : Reactor Transfer Functions by C. Sastre (pp. 1-39); Heat Exchangers in Nuclear Power Plants by G. T. Lewis, M. Zizza, and P. De Riewzo (pp. 41-106); The Formation of Free Radicals in Polymers by Radiation, their reactions and reactivities by M. G. Ormerod (pp. 107-138); Measurement of Reactor Parameters in Subcritical and Critical Assemblies (pp. 139-183); Scattering of Thermal Neutrons from Solids and Their Thermalization near Equilibrium by L. S. Kothari and V. P. Duggal (pp. 185-302); and Some Aspects of the Use of Digital Computers in Nuclear Reactor Design by B. W. Roos and W. C. Sangren (pp. 303-359).

The titles indicate that the range of topics covered include all disciplines—mathematics, physics, chemistry and engineering. Each article surveys the latest progress in the subject concerned and the ample references given at the end bring the literature quoted to the year 1962, and in some cases to as late as 1963.

The valuable material contained in this volume will be useful not only to nuclear technicians and engineers but also to physicists and chemists whose subjects of interest are connected with nuclear science. A. S. G.

Advances in Food Research, Volume XII. Edited by C. O. Chichester, E. M. Mrak and G. F. Stewart. (Academic Press, New York and London), 1964. Pp. ix + 433. Price $ 14.00.

As with its predecessors, this volume offers a rich and varied fare by authors internationally chosen and each an authority in his subject. Seven articles comprise the book.

T. M. Reynolds reviews the reactions between aldoses and simple amines in the context of the deteriorations in foods resulting from chemical reactions. These have been extensively studied ever since Maillard first described the general reactions between amino-acids and reducing sugars. Indeed, non-enzymatic browning has come to be recognised as a tantalizingly broad and unlimited subject involving complex reactions between amines, reducing compounds, proteins, non-nitrogenous components in foods and chemical inhibitors and additives. The present report brings out some major obvious gaps in our knowledge of the subject.

Osmophilic yeasts could cause spoilage in foodstuffs commercially preserved by drying, sugaring or salting. They could also be of value in contributing to the subtle flavours during ripening of fermented soya products such as miso paste and soya sauce. H. Onishi's review is particularly concerned with the soya yeasts, their taxonomy, physiological adaptation, and nutritive and ecological aspects. The mechanism of salt or sugar tolerance needs to be elucidated and perhaps studies on the metabolism of nucleic acids and phosphates and on the biosynthesis of cell wall constituents, which are major topics of current study elsewhere, may yield useful information.

Controlled atmospheric storage of foods with special reference to use of carbon dioxide and refrigeration which can retard ripening or senescence and inhibit spoilage organisms are reviewed extensively in two reports. W. H. Smith discusses the optimum conditions for use of carbon dioxide in the storage of a variety of fruits and vegetables and effects on post-harvest physiology. Developments in marine refrigeration with attention to details of design of refrigerated ships for transport of various food cargoes of animal and vegetable origin are elaborated by K. C. Hales.

An ambitiously prepared account by J. S. Pruthi gives valuable information on the physiology, chemistry and technology of the as yet little known and used passion fruit of tropical and sub-tropical origin. Literature relating to taxonomy and agri-horticultural aspects are included.

The new and growing category of synthetic gums, chiefly cellulose derivatives, acrylates and vinyl polymers which are rapidly replacing the thickening agents of plant origin, are instructively covered by M. Glicksman who, in discussing their various uses, enumerates their advantages in that they 'permit more accurate tailoring of chemical structure to the desired product properties for specific applications'.

It is inevitable that in compilations of this kind the coverage of topics get too broad-based to be coherent but the fact that each reviewer has aimed to include sufficient details gives the reader a feeling of personal acquaintance with the subject and, therefore, an appreciation of the total effort.   A. S.

Vitamins and Hormones, Volume XXI. Edited by R. S. Harris, I. G. Wool and J. A. Lorraine. (Academic Press, New York and London), 1963. Pp. 374. Price $ 13.00.

This series publication contains six very valuable chapters on (1) Intrinsic Factor ; (2) Vitamins A and D, Cartilage, Bones and Teeth ; (3) Modified Thiamine Compounds ; (4) Inter-relations between ' Vitamin B_6 and Hormones (5) Corticosteroids and Enzyme Activity ; and (6) The Endocrine System and the Stomach, compiled by authorities in the specific fields of research.

Recent studies on the mechanism of vitamin B_{12} absorption shows good evidence for the existence of a "releasing factor" and a "transfer factor". More data on intrinsic factor should prove very valuable in intermediary metabolism as important new reactions necessitating a requirement for cobamide coenzymes are found. For quite some time now, there has been a dearth of a critical review on the evidence for and against any direct effects of vitamins A and D on skeletal and dental tissue which has been fairly exhaustively discussed in the second chapter. The interrelationship between vitamins A and D, in the activity of the osteoblasts, calcification and osteoclastic action has been clearly demonstrated along with the effects of hypo- and hypervitaminosis A and D. From the chapter on modified thiamine compounds, it is clear that changes in methyl radical, the

methylene bridge or the side chain results in reduction or complete loss of activity, the exception being on ethyl substitution at the 2-position of the pyrimidine moiety which causes an increase in thiamine activity. The next chapter deals with the effect of vitamin B_6 on the function of thyroid, adrenal and gonadal steroids. That the administration of certain tuberculosis agents, such as INH, can lead to syndromes of vitamin B_6 deficiency which could be reversed by B_6 are now demonstrated. The last two detailed chapters on corticosteroids and enzyme activity, and the endocrine system and the stomach excellently review the role of various biological constituents in intermediary metabolism in the rodent as well as in human subjects.

I would unhesitatingly say that this volume also contains very valuable material, excellently reviewed and discussed like the previous volumes in Vitamins and Hormones, and should prove of immense benefit to biochemists and, in particular, to medical research teams.

                          H. R. CAMA.

Experimental Pharmacogenetics—*Physiopathology of Heredity and Pharmacologic Responses.* By Hans Meier. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xi + 213. Price $ 7.50.

While considerable attention has been paid to the importance of genetic background in the breeding programme of laboratory animals for cancer research and study of nutritional influences on disease processes, the same emphasis has not been placed so far, on animals needed for drug action and other pharmacological investigations.

The studies of microbiologists engaged in elucidating the mode of action of drugs on bacteria, of human geneticists trying to co-relate the drug action with genetic background and of cytologists observing drugs that influence heredity have revealed a considerable degree of interdependence of 'drug action and heredity'.

In the process of breeding, species become more or less profoundly modified with differences becoming apparent when subjected to experimentation.

Since mutations identical to man have occurred in various species of animals, it has been possible to establish colonies that simulate human groups in their response to drugs.

This monograph reviews heritable features recognised by the use of drugs and hereditary defects altering drug responses in some species of animals.

The availability of animals carrying specified genes or mutant types which could be precision tools for biochemical studies involving metabolic disorders and pathological effects of single genes has also not been widely known and appreciated.

With suitable examples, the author has focussed attention on the use of such mutants in elucidating many facets of intermediary metabolism. 'Potentialities for and pharmacological research in inbred mice' lists the mutant genes maintained at the Jackson Laboratory, presents the differences between inbred strains of mice and discusses the strain specific pharmacologic responses.

The other species whose hereditary characteristics of pharmacological interest are discussed in this volume pertain to rats, hamsters, rabbits, guinea-pigs, dogs, cats and some farm animals. 'Comparative aspects of blood coagulation' dealing with the normal and abnormal coagulation and clotting factors in animals, reviewed in this booklet, offers a new approach for enhancing our knowledge and understanding of some hæmorrhagic disorders in man.

<div align="right">M. Sirsi.</div>

Handbook of Preparative Inorganic Chemistry, Vol. I. Edited by G. Brauer. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. 1002. Price $ 36.00.

This is the American translation of the second edition of Vol. I of the well-known *Handbuch der Praparative Anorganischen chemie* (in two volumes) published in 1960. In the resurgent field of Inorganic Chemistry, the translation will go a long way in aiding the workers all over the world, and this sturdily bound book is a necessary addition to all laboratories.

The first part (107 pages) deals briefly with preparative methods, the apparatus, their materials of construction, the manipulative techniques, temperature and vacuum systems commonly employed, etc. The rest of the book deals with more than 800 inorganic preparations and basic properties of the compounds of about 65 elements (the rare earths and noble metals are excluded). The translation editor, R. F. Riley, has made some changes in the text to suit the apparatus and materials commonly in use in America. A good index would have been welcome ; the list of formulæ and contents hardly cope with the anticipated usage of the book.   G. B.

The Formation of Wood in Forest Trees. Edited by Martin H. Zimmerman. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xv + 562. Price $ 16.00.

This book, edited py Dr. Zimmermann of Harvard University, is a compilation of 29 papers presented at the second symposium held under the auspices of the Maria Moors Cabot Foundation for Botanical Research, Harvard Forest, April 1963. The foundation was set up by Late Godfrey Lowell Cabot with the laudable aim "to increase the capacity of the earth to produce fuel by the growth of trees and other plants". Prof. Kenneth V. Thimann, the present Chairman of the Foundation, however, remarks in his introduction that the original aim of the Foundation of improving growth of the trees has gradually drifted towards studying the more fundamental problems of tree growth. A critical perusal of the book also supports this proposition, although some of the very useful topics having a direct or indirect bearing on the problem of wood formation have been covered in this volume. These include 'the role of water in wood formation', 'the role of endogenous hormones in cambial activity and xylem differentiation', 'some indirect effects of environment on wood formation', and 'relation of transport to growth in dicotyledonous trees'. Since the cambium is directly responsible in the formation of wood in dicotyledonous trees, there is no wonder that it has received a major treatment.

The whole volume is divided into four parts, *viz.*, (1) The cambium and its derivatives ; (2) Biochemistry of cambial derivatives ; (3) The translocation of photosynthetic products to the cambium ; and (4) Internal and external control of wood formation. Each part consists of a number of papers, in all 29 papers have been presented by some 26 workers, many of them very distinguished in their fields. At the end of the book an author index and a subject index are also given. The discussions provided at the end of the papers are very illuminating and help in further elucidating some of the key problems. Among the participants in the discussions are, eminent workers like Bailey, Esau, Barghoorn and Thimann.

This volume which is lavishly illustrated with neat drawings and photographs, including electron micrographs, will be of great interest to wood anatomists, forest physiologists and biochemists.

<div align="right">K. N. Kaul.</div>

Books Received

The Sources of Science—Experiments and Con-sideration Touching Colours. By Robert Boyle (Johnson Reprint Corporation, 111, Fifth Avenue, New York), Pp. xxvi + 423.

Indian Woods (Vol. II)—*Their Identification, Properties and Uses—Linaceæ to Moringaceæ.* (The Manager of Publications, Delhi), 1963. Pp. x + 386. Price Rs. 32·50.

Mossbauer Effect—Principles and Applications. By G. K. Wertheim. (Academic Press, New York), 1964. Pp. viii + 116. Price $ 2.45.

Potential Barriers in Semiconductors. By B. R. Gossick. (Academic Press, New York), 1964. Pp. x + 153. Price $ 2.45.

Elementary Dynamics of Particles. By H. W. Harkness. (Academic Press, New York), 1964. Pp. ix + 219. Price $ 2.95.

Elementary Plane Rigid Dynamics. By H. W. Harkness. (Academic Press, New York), 1964. Pp. ix + 191. Price $ 2.95.

The Chemical Society—Annual Reports on the Progress of Chemistry for 1963, Vol. LX. (The Chemical Society, Burlington House, London W. 1), 1964. Pp. vi + 681. Price $ 2.00.

Crystals—Their Role in Nature and in Science. By C. Bunn. (Academic Press, New York), 1964. Pp. viii + 286. Price $ 3.45.

Counterexamples in Analysis. By B. R. Gelbaum and John M. H. Olmsted. (Holden-Day, Inc., San Francisco), 1964. Pp. xxiv + 194. Price $ 7.95.

Ways of Thoughts of Great Mathematicians. By Meschkowski. (Holden-Day, Inc., San Francisco), 1964. Pp. viii + 110. Price : Clotn $ 5.95 ; Paper $ 3.95.

Documents on Modern Physics—Theory of Crystal Dislocations. By A. H. Cottrell. (Gordon and Breach, 150, Fifth Avenue, New York-11), 1964. Pp. ix + 91. Price : Cloth $ 4.50 ; Paper $ 2.50.

Soils of India. By S. P. Raychaudhuri, R. R. Agarwal, N. R. Datta Biswas, S. P. Gupta and P. K. Thomas. (Indian Council of Agricul-tural Research, Krishi Bhawan, New Delhi), 1963. Pp. vi + 496.

Pure and Applied Mathematics (Vol. XV)—*Geometry of Manifolds.* Edited by P. A. Smith and S. Eilenberg, 1964. Pp. ix + 273. Price $ 10.50.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the Ph.D. Degree in Nuclear Physics to Shri K. Pardha-saradhy for his thesis entitled "Studies on the Absolute Photoelectric Cross-Sections of Gamma Rays"; D.Sc. Degree in Nuclear Physics to Shri K. Venkata Reddy for his thesis entitled "Level Scheme and Angular Correlations of Certain Even-Even Radioactive Nuclei".

Allahabad University has awarded the D.Sc. Degree in Chemistry to Dr. Surendra Nath Sinha for his thesis entitled "Studies on Metal Chelates of Some Lanthanons in Aqueous Solution".

Indian Phytopathological Society

The 15th and 16th Annual Meetings of the Society were held on December 29 and 30, 1964 at the University College of Science and Techno-logy, Calcutta. Prof. T. S. Sadasivan (Presi-dent for 1963) and Dr. S. Sinha (President for 1964) delivered their Presidential Addresses. A symposium on "Host Parasite Relationships in Plant Diseases" and a Session for reading of scientific papers were held. Shri M. J. Nara-

simhan delivered the Second Mundkur Memorial lecture on December 29 and Academician Professor N. A. Krasilinikov addressed the Society and gave a lecture on "Soil Micro-organisms in relation to Phytopathogens" on December 30.

Gas-Liquid Chromatography to Assess Milk Quality

Experiments at the National Institute for Research in Dairying at Shinfield, Reading, Berkshire, have demonstrated that gas-liquid chromatography can be successfully used in assessing milk quality. Since this technique is easily automated it may be possible to adapt it as the basis for an automatic test at milk factories.

As is well known in gas-liquid chromato-graphy a very small sample of the mixture is carried by an inert gas through a narrow column where it contacts a liquid phase that delays the passage of individual components for slightly different periods, thus separating them. They escape in turn *via* a detector that records the emergence of the components as a series of

peaks on the chromatogram—each peak being characteristic for any one component.

When milk turns sour due to bacterial action, the main product is non-volatile lactic acid, but traces of volatile chemicals are also formed. Small amounts of these are normal constituents of fresh milk—souring merely alters their amounts and relative proportions. The pattern of peaks on a chromatogram of fresh milk there-fore differs from the pattern produced by milk that is turning sour and the differences indicate how far deterioration in quality has progressed. Thus the chemical changes associated with souring are readily detectable by gas-liquid chromatography.

A stream of nitrogen gas, passed upwards *via* a hypodermic needle into a vertical glass tube containing a 0·2 millimetre sample, causes the milk to bubble up and form a film on the inside of the tube. The volatiles, entrained by the nitrogen stream as it sweeps past this com-paratively large area of milk, are then trapped in a cooled metal coil. When this coil is warmed electrically, the volatiles pass on into the chromatograph where analysis is effected in about 20 seconds.—(*Brit. Inf. Serv.*)

Dislocations in Polymer Crystals

The recent discoveries that high polymers are capable of forming chain-folded lamellar single crystals when deposited from dilute solution, and that lamellar crystals of a similar nature are present in many bulk polymers, have aroused interest in the growth and properties of chain-folded molecular crystals. These crystals have been most widely studied in polyethylene, but attention has been confined, for the most part, to what may be considered properties of the *ideal* crystal. Properties sensi-tive to defect structures within *real* crystals have received no thorough investigation. It is known that giant screw dislocations are com-monly present during growth and often give rise to growth spirals or terraced growth pyramids, and that Moire patterns occasionally reveal features probably indicative of the presence of edge dislocations.

In a contribution to the *Journal of Research* (A), National Bureau of Standards, H. D. Keith of Bell Telephone Laboratories, and E. Passaglia examine the role that dislocations are likely to play in chain-folded polymer crystals, parti-cularly with regard to their influence on plastic deformation. It is assumed that primary bonds cannot be broken in backbone molecular chains ; and this restriction, together with further restrictions brought about by chain-folding, limits substantially the number of permissible dislocations and glide processes. It is shown that dislocations are unlikely to play a major part in bringing about deformations of appre-ciable magnitude in chain-folded polymer crystals.—[*Jour. Res.* (A), Nat. Bureau Std., 1964, 68, 513.]

A New Hypothesis for the Red-Shift in the Spectra of Distant Stars

It is known that the lines in the spectra of distant stars show a red-shift which is propor-tional to the distance of the star from the observer. This is usually interpreted as a Doppler effect due to an assumed "expansion of the universe". Attempts have been made to explain the observed red-shift by the assump-tion that a photon travelling through space continually loses energy at a constant rate. Controversial opinions have been expressed as to how such a loss of energy could take place.

In a communication to *Physics Letters* (1 December 1964), R. Fürth proposes a mechanism for the loss of energy of the photons which assumes only gravitational effects on photons and leads to a numerical value for the expected red-shift of the right order of magnitude.

According to classical electrodynamics an electron, forced to move along a circular path, emits electromagnetic radiation and therefore continually loses energy or, in modern parlance, emits a very large number of low energy photons at a constant rate. Similarly one might imagine that a photon, forced to move along a curved path in a gravitational field, steadily loses energy by sending out "gravitational waves" (or emitting "gravitons").

Applying the quantum-mechanical treatment combined with the laws of electrodynamics applicable to electron, to the present case of a centripetally moving photon in a gravitational field, Fürth shows that the time dependence of the energy E of the system can be written as $E = E_0 \exp(-\epsilon l/R)$, where E_0 is the original energy of the photon on its emission from the source and l is the distance travelled by it, and ϵ a numerical constant of the order of unity. The red-shift for sufficiently small $\epsilon l/R$ will thus be $\Delta\lambda/\lambda \approx \epsilon l/R$. If it is assumed that the universe is a "closed sphere" of average curva-ture $1/R$, the photons travelling in such a universe will follow curved paths of this curva-ture, and R would then be the "gravitational radius" of the universe.—(*Physics Letters*, Amsterdam, 1964, 13, 221.)

A Capture Theory of the Origin of the Solar System

At present there is no completely acceptable theory of the origin of the Solar System. Current views on the problem are contained in the Proceedings of a Conference on the subject held in 1962 (see *Curr. Sci.*, July 20, 1964, p. 444). Two theories, however, hold the field as bases for any development in the subject. The nebular theory postulates that planets were formed during the process of condensation of the Sun. The tidal theory postulates a 'near collision' of the Sun with a second passing star, which resulted in drawing out a filament of gas from the Sun, from which condensation into planetary bodies subsequently occurred. It will be noted that in both the theories the material of the planets was at one time part of the Sun itself.

In a recent communication to the *Proceedings of the Royal Society* (A, 1964, 282, 485), M. M. Woolfson describes a new theory of the origin of the Solar system. It is essentially a tidal theory but one which involves a process hitherto not considered, namely, that the star which passed near the Sun was lighter and less dense than the Sun and itself provided the planetary material. Woolfson examines by a series of computations the conditions for such a mechanism and indicates the possibility that two stars may interact under gravitational forces alone in such a way that material from one may be captured by the other.

The 'capture' theory so far developed in the paper explains a number of the more important and grosser features of the Solar System. It is shown that planetary condensations could be formed and that these would take up orbits with radii having the required range of values. The distribution of angular momentum is reasonably well accounted for. It is to be noted that the angular momentum of the planets is derived directly from that of the star around the Sun, while the Sun would have scarcely been affected by the encounter. The 'capture' theory also postulates a cold origin of the material of the planet.—(*Proc. Roy. Soc.*, A, 1964, 282, 485.)

Melinex Polarizer for the Near Infra-Red

A widely used transmission polarizer in the near infra-red region is the 'pile of plates' type employing thin polythene film. The ready availability of large sheets of thin film makes it easy to construct such polarizers, including large area ones, in contrast to the traditional selenium or silver-chloride types. However, polythene suffers from the disadvantage that its transmission steadily decreases with wavelength below $5\,\mu$ (due to bulk absorption and scattering) and it possesses a very intense absorption band in the region $3\cdot3-3\cdot6\,\mu$.

It has been found that polarizers made of stack of thin Melinex (polyethylene terephthalate) possess advantages over the polythene polarizers for the near infrared. By comparison Melinex has a greater number of absorption bands, but only two of these are strong ($3\cdot35\,\mu$ and $5\cdot15\,\mu$), and neither is as intense as the $3\cdot45\,\mu$ of polythene. At all wavelengths from $1-5\,\mu$ the transmissions of Melinex is better than that of polythene.

At present Melinex may be obtained more readily than polythene in extremely thin sheets which are desirable to minimize the absorption and the lateral displacement of the radiation, thus obviating the necessity for a compensated arrangement. However, Melinex has sufficiently good transmission and surface finish for interference effects in the films to be of importance. This may be valuable in certain applications requiring exceptionally high polarisations—in other cases it may be a disadvantage.—(*Jour. Sci. Inst.*, 1964, 41, 687.)

Scintillations of Stellar Radio Sources

The quasi-stellar radio sources, sometimes called quasars, have been observed to fluctuate randomly in intensity by as much as 60% in a period of one or two seconds. This rapid fluctuation is superposed on a more gradual fluctuation that extends over a period of weeks or months.

While there is as yet no proper explanation for the slower fluctuation, Hewish, Scott and Wills of the Cambridge University Radio-astronomy Division, suggest that the rapid fluctuations are evidently caused by the solar wind, the tenuous stream of charged particles emitted outward by the sun. The solar wind creates disturbances in interplanetary space resembling that created in the earth's atmosphere by ordinary winds and convection currents. Thus the quasars, which have very small apparent diameters seem to twinkle like stars. Radio sources of extended diameter such as radio-galaxies are immune to interplanetary scintillation even as the larger planets resist atmospheric scintillation—*Sci. Amer.*, November 1964.)

THE NEW PHYSIOLOGY OF VISION

Chapter XI. The Carotenoid Pigments

Sir C. V. RAMAN

THE carotenoids are a group of carbon compounds which owe their colours to a special feature in their molecular structure, *viz.*, the presence of numerous conjugated double bonds forming an elongated chain of carbon atoms joined together by such bonds. Many carotenoids are to be found occurring naturally. Thirty of these compounds of which the structure has been fully elucidated by chemical investigation are listed in the well-known treatise on the carotenoids by Karrer and Jucker (Elsevier, 1950). Their structural formulæ have there been shown in tabular form, and supplemented by another table setting out their classification as derivatives of lycopene and the three known carotenes. Of particular interest are twelve photographs in colour reproduced towards the end of the treatise. These pictures show the forms of the crystals of various carotenoids deposited from solution in appropriately chosen organic solvents.

Amongst the thirty naturally occurring carotenoid pigments of known chemical constitution listed by Karrer and Jucker, two are of particular interest in the present context, *viz.*, β-carotene and xanthophyll. Their chemical formulæ are respectively $C_{40}H_{56}$ and $C_{40}H_{56}O_2$. The chemical composition of xanthophyll is indicated by its formal description as dihydroxy-a-carotene. Both of these carotenoids are to be found widely distributed in nature. They appear invariably in the green parts of living plants as accompaniments of chlorophyll and presumably therefore play special roles in photosynthesis. Both carotenoids find their way into the human body by way of the food products consumed by the individual. They have been located in human blood serum, in fat tissues, in milk fats, in the liver and in the human placenta. β-carotene is of special importance in human physiology by virtue of its being a precursor of Vitamin-A which is essential for human health. Xanthophyll, on the other hand, does not serve as a precursor of Vitamin-A. The reason for this difference is intelligible. β-carotene has symmetric molecules which in appropriate circumstances can split into two equal fragments, each of which by the addition of a water-molecule acquires a terminal hydroxyl group and becomes a molecule of Vitamin-A. Such a splitting could scarcely be expected to occur in the case of xanthophyll, as this substance has unsymmetrical molecules in which a hydroxyl group is already present in each of the closed rings at the ends of the molecule.

Spectroscopic Behaviour of the Carotenoids.— Towards the end of the treatise by Karrer and Jucker appear 28 figures in which the light-absorption curves of numerous carotenoids dissolved in organic solvents are reproduced. A study of these figures is highly illuminating. With some significant exceptions, the absorption by these pigments appearing in the visible region of the spectrum is restricted to its blue-violet sector, in other words, to the wavelengths between 400 mμ and 500 mμ. Another general feature is the appearance within this range of the spectrum of alternate maxima and minima, there being usually three maxima of absorption. Following such alternations, there is a steep drop in absorption as we proceed towards longer wavelengths, and this is followed by a feeble absorption extending a little beyond 500 mμ before it finally vanishes. Towards shorter wavelengths, there is also a fall which is distinctly less rapid, the absorption becoming weak at 400 mμ and weaker still in the near ultra-violet. These features are illustrated in Fig. 1 for the a- and β-forms of carotene. The

β-Carotene in Hexane

a-Carotene in Hexane
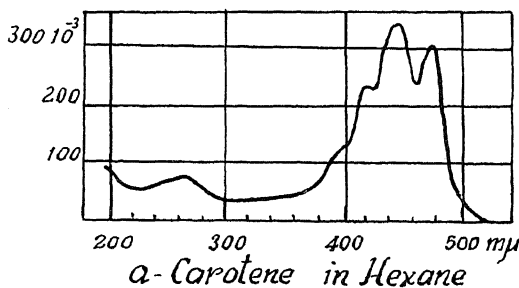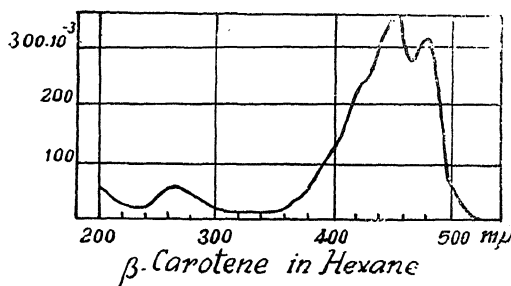
FIG. 1. Light Absorption Curves

two corresponding dihydroxy derivatives known as xanthophyll and zeaxanthin exhibit absorption curves closely resembling those of the respective carotenes. It should be mentioned that the precise positions of the maxima of absorption between 500 mμ and 400 mμ are noticeably influenced by the choice of solvent for the observations. The actual positions of the maxima observed in hexane solution are for β-carotene 477 mμ, 450 mμ and 425 mμ. The corresponding figures for xanthophyll in alcohol solution are 476 mμ, 447 mμ and 420 mμ.

The relationship between the colour and the constitution of carotenoids have been extensively studied and empirical relations have been deduced. These will be found set out fully and discussed in the treatise of Karrer and Jucker. The absorption of light by the carotenoids in the visible region of the spectrum has been ascribed to electronic oscillations along the chain of conjugated double bonds. It can be predicted on this basis that the wavelengths and intensities of the maxima of absorption would increase with the number of conjugated ethylenic bonds in the molecule.

Of particular significance are the exceptions to the general rules regarding the form of the absorption curves which have been stated above. It will suffice to mention here three such cases, viz., rhodoxanthin ($C_{40}H_{50}O_2$), astaxanthin ($C_{40}H_{52}O_4$) and astacene ($C_{40}H_{48}O_4$). Their absorptions extend into the visible spectrum well beyond the usual limit of 500 mμ. Such extension is accompanied by noteworthy changes in the form of the absorption curve, the alternation of maxima and minima between 500 mμ and 400 mμ becoming less pronounced or even completely disappearing. A single wide-band maximum is then observed in this region. These features are illustrated in Fig. 2. All three carotenoids whose absorption curves appear in the figure are derivatives of β-carotene. The changes noticed in their absorption curves are the result of the introduction of oxygen atoms, each replacing two hydrogen atoms, in the closed rings which terminate the molecule. Astacene, for example, in which the wide-band maximum of absorption appears at 500 mμ may be described as tetraketo-β-carotene. That the spectroscopic behaviour of β-carotene is profoundly altered by this change in the chemical nature of the end groups in the molecule is not surprising.

Role of the Carotenoids in Vision.—Visual pigments function by reason of their presence in the retina as well as their ability to absorb light in particular regions of the spectrum and to transfer the energy thus absorbed through the optic nerves to the cerebral centres of perception. By reason of the powerful absorption of light exhibited in the wavelength range between 400 mμ and 500 mμ, carotenoid pigments are qualified to function as receptors of vision in this range. Studies on the visual perception of polarised light in the blue-violet sector of the spectrum and its relation to the
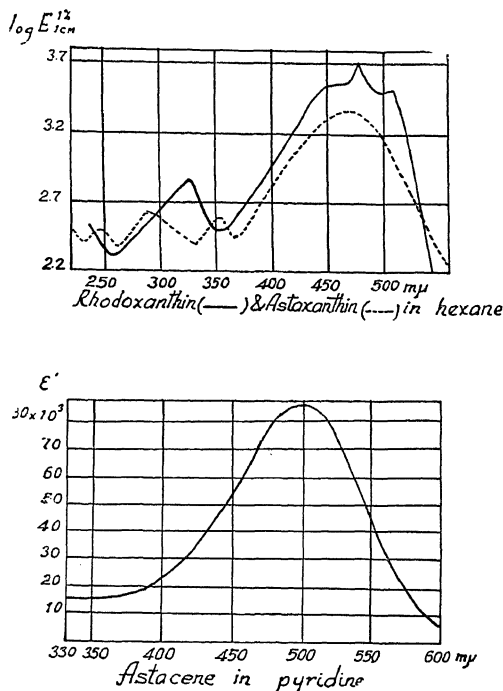
FIG. 2. Light Absorption Curves

structure of the fovea have been described in two earlier chapters. They pointed to the conclusion that a carotenoid is indeed the visual pigment which enables us to perceive light and colour in that range of the spectrum. We shall revert to the same theme in the present chapter and describe further observations which confirm the stated finding and enable us to identify the pigment as xanthophyll.

The nature of the visual pigment functioning at low levels of illumination is another problem of great interest. It is a characteristic of vision at low levels of brightness that we do not perceive the red end of the spectrum and in consequence, dim-light vision is practically confined to the spectral range between 400 mμ and 600 mμ. It has been shown in an earlier chapter that the ability to perceive feeble light

with these spectral characteristics is not an exclusive feature of "rod vision", since it is exhibited just as perfectly by the cones in the retina. The ability to perceive dim light is indeed a general and fundamental aspect of human vision. From the spectral characteristics of dim-light vision, we may proceed to infer the features which we may expect to find exhibited by the light-absorption curve of the visual pigment which enables us to perceive dim light. This, in its turn, should assist us in identifying the pigment. Visual observations of the spectrum of dim light show that its maximum brightness is located at about 500 mμ. What has been stated above and is illustrated by the absorption curves reproduced in Fig. 2 indicates that the visual pigment functioning in dim light is a derivative of β-carotene in which the two groups at the ends of the molecule have both been modified suitably so as to give an absorption curve of the same general shape as that of astacene shown in Fig. 2. We shall consider this matter more fully as we proceed.

Colour and Luminosity in the Spectrum.— Much knowledge regarding the visual perceptions of luminosity and colour emerges from very simple observations made with a long straight metallic filament stretched inside a tubular lamp and carrying an electric current as the source of light, and a replica-diffraction grating held before the eye as the dispersing apparatus. Altering the current through the filament with the aid of a rheostat, the light emission can be raised step by step from a dull red glow to the intense white light emitted by the filament at the highest temperature which it can carry. The results of the observations thus made will be described and discussed in a succeeding chapter. Here, we shall confine ourself to those features which have a bearing on the present topic, *viz.*, the nature of the visual pigments which function in the blue-violet sector of the spectrum.

In the continuous spectrum of a moderately luminous source of white light, an observer can readily trace a progression of colour and luminosity as we pass along the spectrum. A feature which is immediately obvious is that the colour alters as we proceed quite slowly in some regions of the spectrum and quite rapidly in others. The transition from the blue to the green of the spectrum is one of the regions in which the changes are particularly rapid. 490 mμ is the wavelength at which the colour changes most rapidly and this can be fixed quite accurately by simple visual observations made with a

wavelength spectrometer. Why such a rapid change occurs at this point in the spectrum is readily understood by reference to the absorption curves of the carotenes reproduced as Fig. 1 above and even better from that of xanthophyll exhibited in Fig. 3.

It will be seen that the strength of the absorption goes down steeply from a large value at 480 mμ to a relatively small value at 500 mμ, the steepest fall being at 490 mμ. Hence, if xanthophyll is the visual pigment which is principally functioning in the spectral range between 400 mμ and 500 mμ, the chromatic sensation excited by it would become weaker and tend to disappear as we proceed from 480 mμ to 500 mμ, while the chromatic sensation excited by the visual pigment functioning between 500 mμ and 550 mμ would *pari passu* gain in strength. The rapid progression in colour and our ability to locate it precisely at 490 mμ are thus accounted for in a very satisfactory manner.
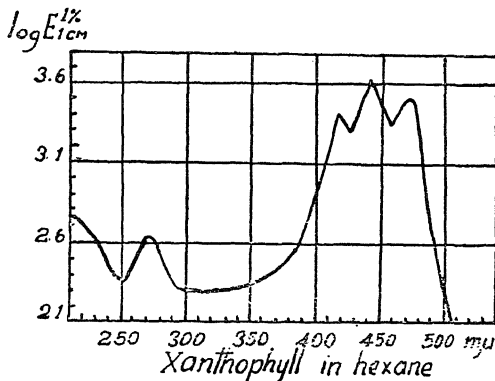
FIG. 3. Light Absorption Curve

It is worthy of remark that the absorption by xanthophyll does not actually disappear at 500 mμ but continues to be sensible at 510 mμ beyond which it ceases to be significant. This is clear from the absorption curves and it may also readily be verified by visual observation of the light-transmission through a solution of xanthophyll (mixed with a little zeaxanthin) obtained by the extraction of the yellow pigment of egg-yolk with hot acetone. With a sufficient absorption path, the cut-off of the spectrum appears at 510 mμ accompanied by a sensible weakening upto 520 mμ, beyond which there is perfect transparency. It follows from these circumstances that the contribution of xanthophyll to the colour perceived in the spectrum should extend well beyond 490 mμ where the change from blue to green is most

rapid. Indeed, visual observation shows that the green of the spectrum has a distinct "blue edging" extending upto about 510 mμ.

Further confirmation that xanthophyll is the visual pigment functioning between 400 mμ to 500 mμ is forthcoming when a continuous spectrum of moderate intensity is surveyed through the eye-piece of a wavelength spectrometer. We notice three points in the spectrum at which impressive changes in its character are noticeable. The first is at 490 mμ as has already been mentioned and discussed. The second is at 465 mμ and the third is at 435 mμ. At 465 mμ, there is a marked change of colour and at 435 mμ there is a marked change of intensity. The three zones in the spectrum thus marked off are also those into which the spectrum is divided by the three peaks of absorption depicted in Fig. 3. The observed differences in colour and intensity between the three zones are explicable in terms of the large differences in the absorptive power of xanthophyll in those regions of the spectrum, when the other circumstances of the case are also taken into account.

Perception of Polarisation.—Still another confirmation that xanthophyll is the visual pigment functioning in the 400 mμ to 500 mμ range of spectrum is furnished by the effects noticed when this region of the spectrum is surveyed from point to point by an observer holding a polaroid in front of his eye and swinging it to and fro in its own plane through 90°. A well-dispersed continuous spectrum exhibiting an adequate intensity over its entire range is essential for such observations. When these requirements are secured, the following features come to light :

(a) The phenomenon of the brushes described in an earlier chapter continues to be noticeable, though much enfeebled, in the region of wavelengths between 500 mμ and 520 mμ. It disappears completely at wavelengths greater than 520 mμ.

(b) The brushes can be seen over the entire range of the spectrum from 500 mμ to the extreme violet end.

(c) Their clearness depends much on the luminosity of the spectrum in the region under observation. There are also indications that it exhibits variations, being greatest in certain regions and distinctly less in others.

Presence of Xanthophyll in the Retina.—The observational evidence set forth above justifies the inference that xanthophyll is present in the living retina and that it functions as a visual pigment. But it is not superfluous to add that its presence is also attested by independent evidence. Xanthophyll may be identified and indeed has been identified in the past as the material responsible for the yellow pigmentation of the macular region of the retina. In a later chapter, we shall also present direct observational evidence for the presence diffused over an extensive area of the retina of a pigment which absorbs light in the blue-violet sector of the spectrum and enables us to perceive light and colour in that sector.

Some remarks regarding the question whether β-carotene is or can be the visual pigment functioning in bright light may be made here. There are weighty reasons for excluding that possibility. Blue-blindness is a very rare condition and this indicates that the visual pigment necessary for the perception of the blue in the spectrum is present in abundant measure with little possibility of its running short. Xanthophyll is not a vitamin precursor and not being needed for other purposes can find its way into the retina through the blood stream to the extent needed and be replenished whenever necessary. If β-carotene were present in the retina along with xanthophyll, it would function as a visual pigment in much the same way. The differences between the form of their absorption spectra might perhaps lead to detectable differences in their functioning. But this possibility scarcely needs consideration, since β-carotene has other physiological functions to perform which make it most unlikely that it is present in unmodified form in the retina to the same extent as xanthophyll.

Perception of Dim Light.—It is indisputable that there is present in the retina a material that enables us to perceive dim light in the spectral range between 400 mμ and 600 mμ and which has its maximum luminous efficiency at or near 500 mμ. But the idea which has so far prevailed that this material is a constituent part of the structure of the "rods" and that it functions only in "rod-vision" is definitely false. As has been shown in earlier chapters, dim light can be perceived also by the cones in the retina, including especially those in the foveal region where there are only cones and no rods. It follows that the visual pigment is spread and distributed through the substance of the retina in such manner as to permit of rods and cones alike functioning in dim light. Studies which base themselves on the extraction of material from the rod-structures by chemical or mechanical methods are therefore not really

relevant to the problem of determining the nature of the visual pigment.

The physiology of vision is concerned with the functioning of the retina in the living state. It follows that we have to rely principally on the actual facts of visual experience and to base their interpretation on other facts and on well-established principles. The basis for all considerations regarding the nature of the visual pigment is, *firstly* that its spectral sensitivity extends over the entire visible spectrum upto 600 mμ, but that it does not extend further towards the red end and, *secondly* that the maximum of its luminous efficiency appears at about 500 mμ. These facts by themselves make it practically certain that the pigment is a carotenoid. Indeed, if we look through the 30 light-absorption curves reproduced at the end of the treatise by Karrer and Jucker, we do not find a single instance in which the strength of the absorption at any wavelength greater than 500 mμ exceeds that at 500 mμ. Nor do we find a single instance in which the authors of that treatise thought it necessary to extend the scale of wavelengths beyond 600 mμ. The reason for this is that in nearly all cases, the absorption ceases to be significant beyond 550 mμ. In a majority of cases, also, the absorption reaches its maximum at or near a wavelength of 500 mμ. As has already been remarked on an earlier page, the wavelengths and intensities of the maxima in the absorption spectra of both natural and synthetic polyenes increase with the number of conjugated ethylenic bonds. The absorption spectra are therefore an indication of the number of such bonds contained in the molecule.

In view of what has been stated above, it may justifiably be inferred that the visual pigment functioning in dim light vision is a carotenoid having the same number of ethylenic bonds as β-carotene. We shall also be justified in inferring that it is a derivative of β-carotene in which the two groups appearing at the ends of each molecule have been so modified as to render its absorption spectrum generally similar to that of astacene represented above in Fig. 2.

Carotenoid chemistry makes extensive use of oxidative and reductive processes in which suitable reagents are employed. Numerous examples of this will be found set out in the chapter on the synthesis of carotenoids in the treatise of Karrer and Jucker. There is present in the retina a substance, *viz.*, oxyhemoglobin, which can transfer its oxygen content to other materials, being itself reduced to hemoglobin in the process. One may, therefore, venture to put forward the suggestion that the transformation of β-carotene to a derivative having an altered spectroscopic behaviour is effected through such oxidation. The pigment thus formed could scarcely be expected to be light-fast. In other words it would break up and result in other substances being formed when exposed to strong light. Its formation can therefore take place only in dim light or in complete darkness. These are, in fact, the characteristic features of the visual pigment functioning in dim light.

Night-Blindness and Its Origin.—The β-carotene that enters the human body by way of the food-stuffs consumed has to play a dual role. It has, in the first place, to function as the parent of Vitamin-A, and in the second place to provide the material needed for vision in dim light. As the supply of β-carotene is limited by the quantity and by the quality of the food-stuffs consumed, it is scarcely surprising that in certain circumstances it may prove insufficient to meet the requirements. As is well known, Vitamin-A is stored up in the liver and also elsewhere in the human body and that the reserves can be drawn upon when necessary. A deficiency in the carotenic content of food would therefore in the first instance result in an inadequate replenishment of the visual pigment which is destroyed by exposure to bright light. This would produce a condition of partial or complete night-blindness, which can, of course, be set right by an increased consumption of food-stuffs containing β-carotene. Alternatively, the addition to the food of material with a large content of Vitamin-A would serve the same purpose. For, this would reduce the major demands for a supply of β-carotene and enable more to be available for vision. It is even possible that the transformation of β-carotene to Vitamin-A in the human body is a reversible process, and that doses of Vitamin-A may remedy the deficiency in the carotenoid input needed for vision.

THE EXPERIMENTAL MANIPULATION OF GENES*

M. S. SWAMINATHAN

Indian Agricultural Research Institute, New Delhi

IT will be 100 years in 1965 since Gregor Mendel presented his paper on "Experiments in Plant Hybridization", in which he propounded the laws of heredity. The science of genetics was, however, born only in this century largely because of the failure of earlier workers to separate continuous from discontinuous variation in their thought and work. Progress in our understanding of the structure, function and mode of inheritance of genes has been phenomenal in recent decades. This is because of the growing knowledge, that while (to quote Kihara) "the history of the earth is written in its layers, the history of living organisms is inscribed in the chromosomes". Chromosomes and the genetic factors they carry have been subjected to a variety of biophysical, biochemical and cytogenetical studies, as a result of which we now know the following. (1) The basic chemical substance of heredity is deoxyribose nucleic acid (DNA), replaced in certain viruses by ribose nucleic acid (RNA). (2) The information needed to specify all the species and individual characteristics of every organism is recorded in its DNA in terms of a non-overlapping triplet code of bases. (3) During gene replication this information is reproduced by the unidirectional assembly of new DNA strands, each complementary in base sequence to the single strand serving as template, the end result being the formation of two daughter molecules of DNA, identical with the parental molecule. (4) The translation of genetic information into protein structure is achieved by the transcription in the nucleus of a specific DNA code sequence into the complementary sequence of bases in single stranded RNA molecule. This messenger RNA leaves the nucleus and serves as the template for the assembly of amino-acids into a polypeptide chain, the ribosomes in the cytoplasm serving as the sites for this reaction. Each specific DNA base triplet would specify a particular amino-acid and the sequence of base triplets specifies the sequence of amino-acids in the final polypeptide product. The recent knowledge on genetic determinants (*see* Tatum[1] for a summary) has enabled the planning and execution of genetic experiments of

great elegance and utility. While much of the most exciting work has been done in micro-organisms, in which the "resolving power" of genetic analysis is exceedingly high,[2] significant break-throughs are also being accomplished in higher organisms. I wish to refer in this short article to a few of the possibilities opened up in the experimental manipulation of gene recombination, mutation and function.

Recombination.—By employing techniques causing denaturation and renaturation of DNA the relationships in the base sequences in nucleic acids could be studied in bacteriophages.[3] It has been shown that any two micro-organisms that can exchange genetic markers by transformation or transduction possess DNA with similar base compositions and can form hybrids on denaturation and annealing. Since there is a close relationship between the ability to form *in vitro* molecular hybrids, and the taxonomy and genetic compatibility of micro-organisms, this criterion could be used as an elegant test of phylogenetic relationships. Such attempts at cross-breeding at the molecular level have been easy in organisms like *Escherichia coli* and bacteriophage T 2 because of the organisation of the genetic units on a single linkage group, the "chromosome" being a single continuous entity (in electron micrographs, the DNA appears filled with uniformly distributed filaments about 25 Å thick and is not combined with histone ; Ris[4] has suggested the term "genophore" to describe the structural counterpart of a linkage group in viruses and bacteria). In higher organisms several distinct chromosomes occur in every genome and each homologous pair cannot be easily isolated. Hence, the denaturation-renaturation technique of forming hybrid DNA molecules does not lend itself for use in higher organisms.

Recombination of genetic factors at the intraspecific level can now be carried out in a purposeful way through the application of various plant breeding techniques (*see* Allard[5] for a recent survey). All the exciting progress that has taken place in plant and animal breeding is due to the purposeful scrambling of genes from diverse sources. Studies on the control of crossing-over have, however, been few, although several workers have shown that linkage can appreciably diminish the response to selection for quantitative characters. For example,

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Mather and Harrison[6] found that the selection response was low where there was linkage between genes affecting the selected character and those affecting fitness. Since the actual mechanism of crossing-over is still not understood fully, studies on the control of crossing-over have to be largely empirical. The use of physical and chemical mutagens to bring about crossing-over particularly in the proximal segments of the chromosomes and thereby help to release the hidden genetic variability, is a promising line of approach.[7] In cross-pollinated plants, linkage tends to be relatively more tight than in comparable self-pollinated plants and hence the possibility of releasing genetic variability through increased crossing-over can be exploited in both these groups (Gupta and Swaminathan, unpublished).

A unique genetic system capable of restricting crossing-over to wholly homologous chromosomes was discovered 6 years ago in bread wheat (*Triticum œstivum*) by Riley and Chapman[8] and Sears and Okamoto.[9] In the absence of a gene located on the long arm of chromosome 5 B, pairing occurred among the homologous chromosomes of the 3 genomes, while in the presence of this gene pairing was confined to the homologous pairs within each genome. This discovery has enabled various types of chromosome manipulations at the inter-specific as well as inter-generic level in Triticineæ. It is not yet clear whether this type of cytological diploidisation mechanism is of general occurrence among polyploid plants.

Developments in the field of applied embryology and organ culture have helped in extending the limits of genetic recombination beyond the frontiers of a species. A recent example of such work is the successful hybridization of the two jute-yielding species, *Corchorus olitorius* and *C. capsularis*.[10] Sears[11] opened up a new era in chromosomal engineering by using a radiation-induced translocation for transferring a gene resistance to leaf rust from *Aegilops umbellulata* to *Triticum œstivum*. Tazima[12] used a similar technique for marking the sex of silkworms at the pupal stage. Translocations serve as a source of gene duplications and Hagberg[13] has employed this tool to study the dosage effect of the gene controlling alpha-amylase activity in barley grains. Since it is known that a heterozygous condition at certain loci, like the V locus in barley, can cause heterosis, duplications will provide a means of creating true-breeding heterozygotes. Induced chromosome aberrations also render the break-

age of tight linkages possible, as demonstrated by Konzak[14] in separating the gene conferring resistance to *Puccinia coronata* from that causing susceptibility to *Helminthosporium victoriæ* in oats.

Mutation.—The knowledge that the sequence and the number of base pairs in DNA determine genetic specificity has helped in planning mutation experiments in micro-organisms at the molecular level. Attempts can be made to attack the gene at 4 different levels—a base pair in DNA (the purines, adenine and guanine and the pyrimidines, cytosine and thymine), a nucleotide (nitrogenous base-sugar-phosphoric acid combination), a cistron (a section of a chromosome that has a unitary function and may consist of several thousand nucleotides) and a chromosome (the gene strings of one human chromosome have been estimated to contain some 4×10^9 nucleotide pairs). Mistakes leading to the alteration of the sequence of the base pairs, such as addition, deletion, inversion and substitution, may occur spontaneously or can be induced artificially. Freese[15] classified the substitution of base pairs into *transitions* (*i.e.*, the replacement of a purine by another purine or a pyrimidine by a pyrimidine) and *transversions* (replacements of a purine by a pyrimidine and *vice versa*). Some of the chemicals used for bringing about such changes artificially are listed in Table I. While the action indicated in Table I represents the most likely one, there could be other effects also. For example, Kreig[16] has suggested that

TABLE I

Types of changes in DNA base pair sequence induced by some chemicals

Chemical		Nature of action
5-bromo uracil	..	G–C $\longleftrightarrow$ A–T transition
2-amino purine	..	G–C $\longleftrightarrow$ A–T transition
Nitrous acid	..	(*a*) A–T $\longleftrightarrow$ G–C transversion
		(*b*) Cross-linking of DNA strands
Hydroxylamine	..	G–C $\longrightarrow$ A–T transition
Ethyl methane sulphonate		(*a*) G–C $\longrightarrow$ A–T transition
		(*b*) Deletion or addition of base pairs
Acridines	..	Deletion or addition of base pairs

EMS-induced mutations may arise from three causes—pairing errors of 7-ethylguanine with thymine, pairing of 3-ethyladenine with cytosine and replication errors at the site of gaps produced by the hydrolysis of 7-ethyl-guanine.

Chemical mutagens have helped to alter the ratios of the different types of chlorophyll

mutations recovered in higher plants, although definite shifts in mutation spectrum are yet to be demonstrated. Swaminathan et al.[17] and Natarajan and Upadhya[18] found that the alkylating agent, ethyl methane sulphonate, breaks chromosomes preferentially at the centromeric and proximal regions. Correlating this observation with the incidence of a high frequency and wide spectrum of chlorophyll mutations in the M 2 progenies of EMS-treated barley, Swaminathan et al.[17] postulated that several of the genes relating to chlorophyll development in barley should be located near the centromere. This prediction has been proved to be correct by subsequent linkage analysis[19,20] (Fig. 1).

BARLEY
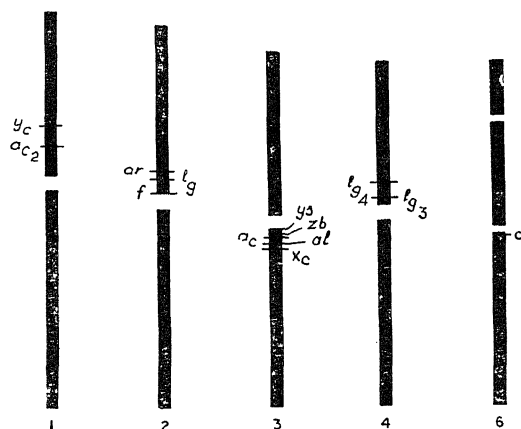
FIG. 1. Genes for chlorophyll development located near the centromere in 6 different chromosomes of barley (data from Robertson[19] and Nilan[20]).

A wide array of physical and chemical mutagens are now available and in most organisms a high frequency of mutations can be induced by devising suitable procedures of treatment and handling. Neutrons have proved to be extremely valuable in such work by virtue of their relative insensitivity to the action of modifying factors, absence of secondary physiological effects associated with their action and high RBE values for the induction of chromosome aberrations and mutations.[21] Through the use of different mutagens, all the known subspecies of *Triticum œstivum* have been recreated.[22]

Looking at the end-product of gene action, namely the protein chain, Ingram[23] first showed that in the abnormal hæmoglobin S, a glutamic acid residue is replaced by valine. In the A-protein of tryptophan synthetase of *E. coli*, a

good correlation was found between induced mutations and amino-acid substitutions (*see* Yanofsky).[24] Thus, it is clear that the replacement of a single base in a code triplet may lead to the substitution of one amino-acid by another in the polypeptide product.

Function.—At the functional level, it has long been known that phenocopies simulating known phenotypes can be experimentally produced. The growing knowledge of the biochemical consequences of a mutation generates the hope that many of the hereditary infirmities in man can be artificially rectified. Such a hope has led Lederberg[25] to call attention, under the term "euphenics" to the enormous future possibilities in this field that can be opened up by molecular biologists through studies of gene expression and function.

The famous biologist Jacques Loeb in his book *The Dynamics of Living Matter* published in 1906 set "experimental abiogenesis" and "the transformation of one species into another" as the two major goals of 20th century biology (cited by Muller).[26] The research on the experimental manipulation of the gene carried out during the past decade has helped us in advancing rapidly towards the attainment of these goals. Those who work in the field of molecular genetics should, however, recognise that the living cell is a unit in which the constituent parts co-exist co-operatively. The knowledge of how genes beget proteins helps us only to understand how a random group of compounds are produced, and not how the many functions of the cell are so beautifully co-ordinated and integrated. Weiss[27] has, hence, rightly stressed the need for more research on how the molecular components of the cell are subordinated to ordered group co-existence in a system of "molecular ecology".

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QUANTUM CHEMISTRY, SOLID STATE PHYSICS AND QUANTUM BIOLOGY

BALU VENKATARAMAN,

Tata Institute of Fundamental Research, Bombay

THE 1964 International Summer Institute in Quantum Chemistry, Solid State Physics and Quantum Biology, where discussions ranged from linear algebra and chemical reactivity to ageing and heredity provided a good illustration of the intermixing between various disciplines in science that has become a happy feature in contemporary research. The institute was one of the series arranged by the Uppsala Quantum Chemistry Group and the Quantum Theory project at the University of Florida, and about 800 scientists have participated in and contributed to these institutes since the first one held in 1958. The present one which was attended by about hundred persons from seventeen different countries was held in two parts : the first one was held at Abisko in Northern Lappland between July 19 and July 31 and the second part at Uppsala between August 6 and August 22.

Abisko is a summer resort in Northern Lappland about 200 kilometres north of the arctic circle and can be reached only by train. It is situated in a real wilderness and due to the intense sunlight, the vegetation in Abisko valley is exceedingly rich and has a pseudo-tropical character. We however missed the midnight sun which could be seen from Abisko only until July 4. The institute was held in the tourist station and this was the only habitation for miles around. Five lectures a day was the minimum and nine hours a day was not uncommon since the weather at Abisko was quite unpredictable.

Uppsala, one of the oldest universities in Europe (1477), where the second part of the institute was held, provided an appropriate environment for serious study in an academic atmosphere. At Uppsala it was normal to have eight lectures a day which were very often followed in the evenings by discussions and question hours.

The entire course was directed by Professor Per-Olov Lowdin of the Quantum Chemistry Group, Uppsala, and the Quantum Theory Project, University of Florida. The other lecturers were : Raymond Daudel (Sorbonne and CNRS, Paris), Frank E. Harris (Stanford University), Masao Kotani (University of Tokyo), Laurens Jansen (Batelle Memorial Institute, Geneva), Bela Lengyel (San Fernando Valley College, California), Andrew Liehr (Mellon Institute, Pittsburgh) and Ruben Pauncz (Technion, Haifa). The problem sessions were handled by the Uppsala Quantum Chemistry Group led by Dr. Jean Louis Calais.

The lectures of Lowdin started with a brief history of Quantum Theory and led on to the application of the methods of linear algebra to quantum theory. Great emphasis was laid on projection operators, the way to derive them from the Cayley-Hamilton equation and their use in component analysis. Cyclic operators, nilpotent operators and normal operators were discussed with examples of their occurrence in quantum theory. Heisenberg's uncertainty relations were derived from the concept of the

width of an operator and these led to Heisenberg's equation of motion and Ehrenfest's relations. These methods were applied in a series of lectures to atomic, molecular and solid state systems and led to a study of the exchange effects, spin effects and the Hartree-Fock schemes for atoms. Crystals were discussed in a brief way and the use of projection operator techniques to derive the Bloch functions from the Born-von Karman conditions was demonstrated. A discussion of the "Tunnelling Effect" was followed by a proposition that tunnelling effect may play an important role in what Lowdin calls "Quantum Genetics", tunnelling of protons could affect gene, DNA, RNA and protein syntheses. Proton tunnelling between the hydrogen-bonded base pairs of the DNA molecule leads to an inversion and hence a mistake in the code and this may be one of the methods of incorporating coding mistakes. Such coding mistakes will have a direct consequence on mutation and ageing; perhaps this may be one of the answers to the problem of evolution and inception of cancer.

A major portion of the second half of Lowdin's lecture series was devoted to a serious study of the time dependent and time independent perturbation theories. The lectures of Lowdin closed with a discussion of bond order and bond lengths, the derivation of the expression for the spin-orbit and Fermi contact couplings and an excellent discussion on density matrices.

Pauncz treated the general theory of angular momentum with the projection operator techniques and applied the results to the treatment of spin and orbital angular momenta and LS-, jj- and intermediate-coupling schemes in atoms. The treatment of theory of the conjugated systems included the simple MO-LCAO method, the pairing theorem for alternant hydrocarbons, a discussion of the reactivity index in aromatic molecules, the Parisier-Parr Pople method and other semi-empirical approaches. His lectures ended with a treatment of the alternant M.O. method where different orbitals are permitted for different spins.

Lengyel had the difficult task of connecting quantum theory with the theory of Hilbert space and for quite a few of the participants this was their first contact with abstract mathematics. Starting from the theory of linear spaces, Lengyel dealt with the concept of norm,

scalar products, bounded self-adjoint operators and the spectral resolution theorem. Harris in the course of his lectures dealt with the expansion of total wave functions in terms of Hartree products and Slater determinants and went through the procedure of evaluating matrix elements between Slater determinants for the various terms of the Hamiltonian. This led to the treatment of the Hartree-Fock scheme and the ASP-MO-LCAO-SCF method; the last four lectures were devoted to an examination of the available computational methods to evaluate correlation terms in the Hartree-Fock Scheme.

Jansen dealt with the problem of crystal stability and put forward a convincing theory to explain why Ne, A, Kr crystallized in fcc and He^4 crystallized in hcp and similarly NaCl and most alkali halides crystallized in two interpenetrating fcc lattices while CsCl, CsBr, CsI crystallized in two interpenetrating simple cubic lattices.

Kotani dealt with many electron atoms in fields of various symmetries and derived many theorems using group theory. The case of spherical symmetry and cubic symmetry were considered and matrix elements were calculated.

Daudel discussed the quantum theory of chemical reactivity and indicated how equilibrium constants (pK values) for acid-base pairs, tautomeric system and singlet-triplet equilibria in biradical and biradicaloid systems, could be calculated. It was postulated that the pK values for tautomerism of the DNA bases being more favourable in their excited state may be one of the reasons for mutagenesis under irradiation. Daudel indicated briefly how the problem of chemical carcinogenesis could be studied by consideration of localization energy.

Liehr's lectures were on Ligand Field Theory. To sum up, the Summer Institute served its purpose by focusing our attention on the trends of recent research in the field of quantum chemistry and one returned with a feeling that a lot still remains to be done both in the fundamental basis of quantum theory and in its applications to physics, chemistry and biology.

LETTERS TO THE EDITOR

NUCLEAR QUADRUPOLE RESONANCE OF Br^{79} AND Br^{81} IN SOLIDS

In continuation of the programme of study of solid state by nuclear quadrupole resonance in this laboratory, resonance signals at room temperature of Br^{79} and Br^{81} are reported for seven compounds. The resonances have been observed using a self-quenched super regenerative oscillator[1] of lecher wire type which has a range of 200 to 400 Mc./s.

The frequencies have been measured with a Marconi TF 1067/1 Heterodyne frequency meter of range 5 to 1000 Mc./s. The compounds are melted into glass tubes for obtaining close packing except for compound (3) which sublimes.

The results of present work together with available literature values are given in Table I.

tioned that our frequency measurement is accurate to $\pm 0 \cdot 5$ Mc./s. taking into consideration the uncertainties in locating the central resonance line (this limitation is common to all super regenerative oscillators). Details of the experimental arrangement and the relation of the frequencies to the structure of compounds will be described elsewhere.

TABLE I
Resonance frequency ν in Mc./s.

Compound		Br^{79}		Br^{81}	
		Present work	Literature value	Present work	Literature value
1 *p*-bromo-acetanilide	..	267·54	..	..	226·805 ⎫ $(77^{\circ}$ K.$)^2$
2 *p*-bromo-acetophenone	..	271·46	..	..	230·670 ⎬ $(77^{\circ}$ K.$)^2$
3 5-bromos-alicylic acid	..	268·66	271·82 $[77^{\circ}K]^3$	..	227·08 ⎭ $(77^{\circ}$ K.$)^{3}$
4 1, 3, 5 tri-bromo-benzene	..	277·17	277·356 ⎫	231·84	234·52
		276·91	277·094 ⎬ (R.T.)³	231·64	234·11 $(77^{\circ}$ K.$)^4$
		275·43	275·744 ⎭	230·26	233·14
5 *p*-bromo phenol	..	264·69	264·733 (R.T.)³	221·28	226·44
					[Average $(77^{\circ}K)^3$ of four lines]
6 2, 4, 6-tri-brome aniline	..	275·75	276·00 ⎫	230·57	230·685 ⎫
		272·41	272·68 ⎬ (R.T.)⁵	227·72	227·875 ⎬ (R.T.)²
		272·01	272·29 ⎭	227·49	227·569 ⎭
7 *p*-dibromo-benzene	..	267·61	267·60 (R.T)⁶	223·70	223·8 (R.T.)⁶

Br^{79} resonances in compounds (1) and (2) are new. In compound (3) Br^{79} resonance was reported at 77° K. while this is observed at room temperature in the present work. In compounds (4) and (5) Br^{81} resonances are observed at room temperature while literature values were reported at 77° K. Compounds (6) and (7) are investigated to test the performance of the oscillator and to compare the accuracy of our frequency measurements. From Table I it is evident that our frequencies agree reasonably well with literature values. It may be men-

Microwave and Magnetic   K. V. S. Rama Rao.
  Resonance Laboratory,   V. Nagarajan.*
Physics Department,   C. R. K. Murty.
Andhra University,
Waltair, *December* 19, 1964.

* Present Address: Department of Physics, Michigan State University, East Lansing Michigan, U.S.A.

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ANGLE OF ARRIVAL OF DOWNCOMING RADIO-WAVES AND IONOSPHERIC IRREGULARITIES

An ionospheric layer which shows horizontal variations may be said to be tilted.[1] This type of horizontal irregularities in the ionospheric layer will cause variations in the angle of arrival of the downcoming radio-waves.[2,3] With a view to understand the nature of variation of the angle of arrival and hence the ionospheric irregularities a systematic study has been undertaken in this laboratory. The method adopted is similar to that used by Wilkins.[4] Two twin matched super-heterodyne receivers with common oscillator are connected to two similar horizontal spaced aerials. The outputs of these receivers are given to the deflecting plates of a cathode-ray oscillograph which produces the phase ellipses on the screen. The angle of arrival θ is obtained from the major and minor axes of the ellipse (a and b) using the equation

$$\cos \theta = \frac{\lambda}{\pi d} \tan^{-1} \frac{b}{a}$$

where λ is the wavelength of the signal received and d is the spacing between the aerials.

Variation in the angle of arrival of radio-waves from Hyderabad ($\lambda = 42 \cdot 02$ m.) at noon was studied for sometime now. Some of the results of these studies have been presented here. It was observed that the angle of arrival undergoes slow and random changes as shown in Fig. 1.
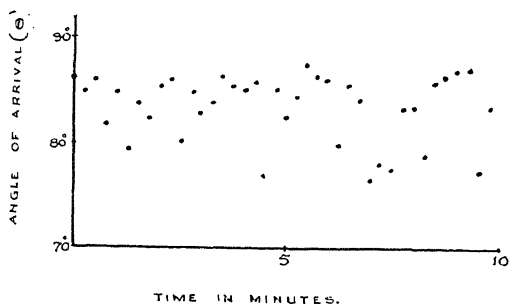
FIG. 1

Banerjee and Mukherjee[5] have arrived at an expression for the angle of tilt ϕ which is small. They have shown that

$$\phi = \frac{2h \, d\theta}{(2h - D \, d\theta)} \qquad (1)$$

where h is the height of the reflecting ionospheric layer and D is the distance between the transmitter and the receiver and $d\theta$ is the change in the angle of arrival. We have arrived at an expression taking a general horizontal sur-

face about which the layer gets tilted, for the angle of tilt. In the diagram (Fig. 2) T and R
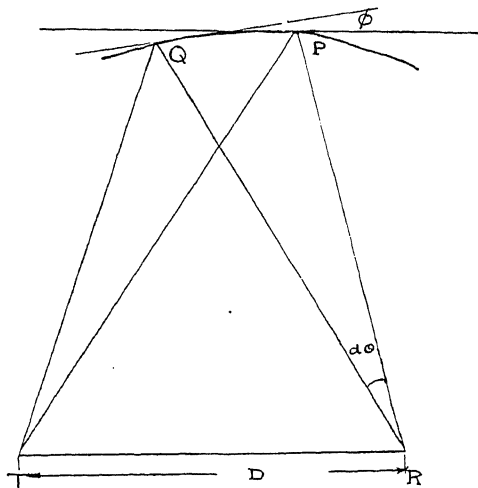
FIG. 2

are the transmitter and receiver separated by a distance D. P is the point of reflection when the layer is horizontal and Q is the point of reflection when the layer is tilted through an angle ϕ about this horizontal direction. These two planes may be considered to be tangential at points P and Q on an ellipse whose foci may be T and R. Then it can be shown that

$$\phi = \frac{1 - e \cos \theta}{1 + e^2 - 2 e \cos \theta} \qquad (2)$$

where $e = D/(\sqrt{D^2 + 4h^2})$, h is the height of the reflecting layer and θ is the mean angle of arrival. From the mean change in the angle of arrival the angle of tilt of the ionospheric layer is obtained using the two formulæ Typical results of five different days have been shown in Table I.

TABLE I

Sl. No.	Mean angle of arrival (θ)	Mean change in the angle ($d\theta$)	Angle of tilt (ϕ) From Formula	
			1	2
1	80° 00′	2° 19′	2° 18′	2° 20′
2	82° 57′	2° 42′	2° 40′	2° 44′
3	81° 36′	1° 52′	1° 51′	1° 54′
4	80° 5′	2° 20′	2° 17′	2° 21′
5	84° 00′	1° 22′	1° 20′	1° 22′

There is close agreement between the values obtained from using the two formulæ.

Department of Physics,   P. Venkateswarlu.
Regional Engineering   V. Venkateswara Rao.
   College,
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OCCURRENCE OF β-EUDESMOL AND PTEROCARPOL IN THE HEARTWOODS OF *PTEROCARPUS INDICUS* AND *P. MACROCARPUS*

IN an earlier publication,[1] the isolation from the light petroleum extract of the wood of *Pterocarpus indicus,* of a steam-volatile terpenoid component, m.p. 80–81°, was reported. Its study has now been pursued. Its elemental analysis agrees with the molecular formula $C_{15}H_{26}O$. Its infrared spectrum indicates the presence of a hydroxyl group (3,300 cm.$^{-1}$), and an exomethylene group (884 and 1,640 cm.$^{-1}$) and is devoid of any absorption due to aromatic system; $[\alpha]_D^{28°} + 35°$ ($c = 1 \cdot 0$; chloroform). These properties agree with those of β-eudesmol (I). That the substance is indeed β-eudesmol has been confirmed by comparing its I.R. spectrum with that recorded for β-eudesmol.[2] Dr. R. G. Cooke, University of Melbourne, informs us (private communication) that he has isolated large quantities of eudesmol from his sample of *P. indicus.*

From the ether extract of *P. macrocarpus* (Burma Padauk) could be obtained a similar sesquiterpene alcohol, now named pterocarpol, m.p. 104–05°, $[\alpha]_D^{28°} + 20°$ ($c = 1 \cdot 0$; methanol). Elemental analysis agreed with the molecular formula $C_{15}H_{26}O_2$. The compound had no characteristic absorption maxima in the U.V. region but in the I.R., absorptions due to hydroxyl (3000 cm.$^{-1}$), exomethylene (1650 and 890 cm.$^{-1}$) were found. Though it was a diol, it yielded only a mono-acetate (m.p. 88–89°) on acetylation with acetic anhydride in the presence of pyridine at 100°. Since the mono-acetate showed a hydroxyl stretching frequency at 3350 cm.$^{-1}$ in the I.R. spectrum there was indication for the presence of a tertiary hydroxyl group in pterocarpol. Catalytic hydrogenation yielded a dihydro derivative, m.p. 120–21°; that the double bond was exocyclic was shown by the liberation of formaldehyde on ozonolysis, identified by chromotropic acid test and by the preparation of the D.N.P. The other product of ozonolysis, a crystalline solid (m.p. 198–200°)

did not answer the iodoform test and had the I.R. absorption at 1710 cm.$^{-1}$ indicative of a cyclohexanone carbonyl.

The carbon skeleton of pterocarpol was established by dehydrogenation both by selenium and palladium charcoal yielding eudalene, identified by its U.V. and I.R. spectra[3] and by means of its picrate, m.p. 92–94°. The identity of eudalene was confirmed by the mixed melting point of picrate with an authentic sample, and by comparison of the I.R. spectra of the picrates.

The presence of the secondary hydroxyl group at C_6 was inferred by the ready oxidation of dihydropterocarpol with dichromate and sulphuric acid in acetone solution to yield a liquid ketone (I.R. 1710 cm.$^{-1}$), which did not form a benzylidene derivative. From these reactions, we assign the structure (II) to pterocarpol, and this is supported by the N.M.R. spectrum.

I   II   III
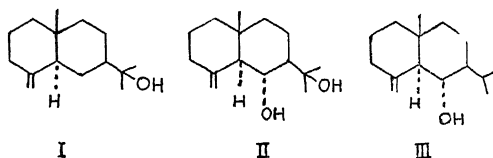
The N.M.R. spectrum of pterocarpol of 60 M C shows the following features: one angular methyl group ($9 \cdot 30 \tau$), a *gem* dimethyl group ($8 \cdot 80 \tau$), two exomethylene protons (as two doublets centred at $5 \cdot 40$ and $5 \cdot 15 \tau$) and one allylic proton (multiplet between $7 \cdot 42 \tau$ and $7 \cdot 20 \tau$). These values agree with those recorded for β-eudesmol.[4] The unsplit signal for the *gem* dimethyl group is indicative of the absence of a proton on the carbon having the two methyl groups and hence the tertiary hydroxyl was placed as hydroxy-isopropyl unit. This is in accord with the presence of a mass peak at 59 in the mass spectrum of pterocarpol. The proton on the carbon bearing the secondary hydroxyl group of pterocarpol showed up as multiplet between $6 \cdot 50 \tau$ and $6 \cdot 00 \tau$ and corresponded to an *axial* proton. Hence the hydroxyl group is inferred to be *equatorially* oriented as in II.

The structural similarity between β-eudesmol and pterocarpol on the one hand and junenol (III)[5] and pterocarpol on the other is quite striking. Further work is in progress.

Dept. of Chemistry,   M. R. Parthasarathy.
Delhi University,   T. R. Seshadri.
Delhi-7, *January* 4, 1965.

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A NOTE ON SOME o-NITROCINNAMALDEHYDE CONDENSATIONS

THE condensation of o-nitrocinnamaldehyde with some malonic acid derivatives has been reported earlier.[1] This note deals with the observations made during the condensation of o-nitrocinnamaldehyde with malon-p-bromoanilic, malon-p-iodoanilic, malon-2 : 5-xylidic, malon-p-ani-

All the products were yellow in colour, crystalline in nature and melted with decomposition. It was also noted that they were all slow to react with sodium carbonate. o-Nitro-cinnamal-malon-2 : 5-xylidic acid has an unexpectedly low melting point (110°).

Table I gives the names of the new products, their molecular formulæ, melting points and the analytical results.

Chemistry Department,   S. KHETAN.
St. John's College,   P. I. ITTYERAH.
Agra, *November* 5, 1964.

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TABLE I

No.	Name		m.p.	% of	Found	Required
1	* X-p-bromoanilic acid	..	$C_{18}H_{13}O_5N_2Br$	224°	Br	19·02	19·18
2	X·iodoanilic acid	..	$C_{18}H_{13}O_5N_2I$	206°	I	27·79	27·37
3	X-2 : 5-xylidic acid	..	$C_{20}H_{18}O_5N_2$	110°	N	7·49	7·65
4	X-p-anisidic acid	..	$C_{19}H_{16}O_6N_2$	205°	N	7·63	7·6
5	X p-phenetidic acid	..	$C_{20}H_{18}O_6N_2$	214°	N	7·32	7·33

* X stands for *o*-Nitrocinnamal-malon.

sidic and malon-p-phenetidic acids. All these acids have been prepared recently in this laboratory. Condensing agent used in these reactions was either pyridine in traces or glacial acetic acid in molecular proportion, the former proving to be better.

In all these condensations only acid products, *viz.*, o-nitrocinnamal-malon-p-bromoanilic, -p-iodoanilic, -2 : 5-xylidic, -p-anisidic and p-phenetidic acids were obtained. All attempts to obtain the corresponding anilides were unsuccessful. This is in agreement with the observations recorded by Bagchi and Ittyerah[2] in their study of some cinnamaldehyde condensations.

The general procedure was to mix equimolecular quantities of the aldehyde and the acid and to add to this pyridine (0·15 mol.). The mixture was then heated at 100° when it first melted to a clear pale yellow liquid and then gradually solidified. Heating was done for four hours and the solid product obtained was purified by recrystallisation from glacial acetic acid. In the case of o-nitrocinnamal-malon-p-anisidic and -p-phenetidic acids aqueous ethanol (50%) was found to be a better solvent.

INTRAMOLECULAR HYDROGEN BONDING IN 5-HYDROXY CHROMONES

RECENTLY, there has been a great interest in the study of 5-hydroxy isoflavones. Several authors[1-5] have reported the existence of intramolecular hydrogen bonding in these compounds from infra-red work. The present note describes the NMR study of three 5-hydroxy chromones, (I) namely (*i*) 5-hydroxy, 7 : 8-dimethoxy isoflavone, (*ii*) 4′, 5-dihydroxy, 7-methoxy isoflavone and (*iii*) 2-methyl 5-hydroxy chromone.
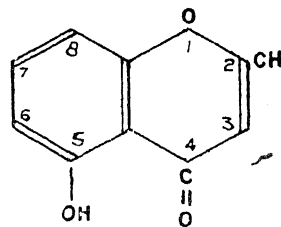
I

The proton spectra of the first two samples were recorded in a very dilute solution (approximately 0·05 M) in tetrahydrofuran and that of the third compound in carbon tetrachloride on a Varian NMR spectrometer operating at 60 Mc./s.

The chemical shifts of the various groups in all the three compounds are given in Table I.

TABLE I

Chemical shifts of various protons in the 5-hydroxy chromones

(Methyl and Methoxy proton shifts are not given)

Compound	Chemical shifts of various protons (in ppm.) rel. to T.M.S.				
	OH proton at position 5	Phenyl protons	Proton at position 2	Proton at position 3	OH proton at position 4
5-Hydroxy 7:8 dimethoxy isoflavone	−12·63	−8·12 to −7·2	−6·46	..	..
4′,5-Dihydroxy 7-methoxy isoflavone	−13·01	−7·5 to −6·37		..	−8·07
2-Methyl 5-hydroxy chromone	−12·32	−7·12 to −6·05	..	−5·38	..

The occurrence of the resonance of the OH proton in position 5 at a very low field (− 12·3 to − 13·0 ppm. rel. to T.M.S. for the various compounds) shows the presence of the hydrogen bonded OH in these cases even in very dilute solutions.

There is a possibility of both intermolecular and intramolecular hydrogen bond formation in these compounds. It is difficult to get information about the intermolecular hydrogen bonding from the study of the concentration dependence of the chemical shift of the OH proton because of the presence of the ring anisotropy effects which, too, are concentration-dependent. Moreover, the compounds have limited solubility. However, at very low concentrations such as those used in recording these spectra, the intermolecular hydrogen bonds are not expected to

be present to an appreciable extent. Hence, it may be concluded that these compounds exist essentially in the hydrogen bonded form II.

It is interesting to compare the chemical shift of the OH proton in these compounds with that of phenolic OH which can form only intermolecular hydrogen bonds. The chemical shift of the phenolic proton has been measured by Huggins *et al.*[6] at various concentrations. They obtained values ranging from − 7·2 to − 6·7 ppm. (rel. to T.M.S.) for the various phenols in pure liquids and − 4·4 to − 4·7 ppm. (rel. to T.M.S.) for solutions in CCl_4 at infinite dilution. The value of about − 12·5 ppm. for the chemical shift of the OH proton in 5-hydroxy chromones is, however, much lower than the chemical shift range observed for phenols. In fact, it is of the same order of magnitude as the shift of the OH proton in carboxylic acid dimers although the bonding in the latter is intermolecular. This presumably happens because the hydrogen bonding involves C=O and OH groups and stable ring is formed in both the cases.

Tata Institute of   G. Govil.

Fundamental Research,   C. L. Khetrapal.

Bombay-5, *December 17, 1964.*

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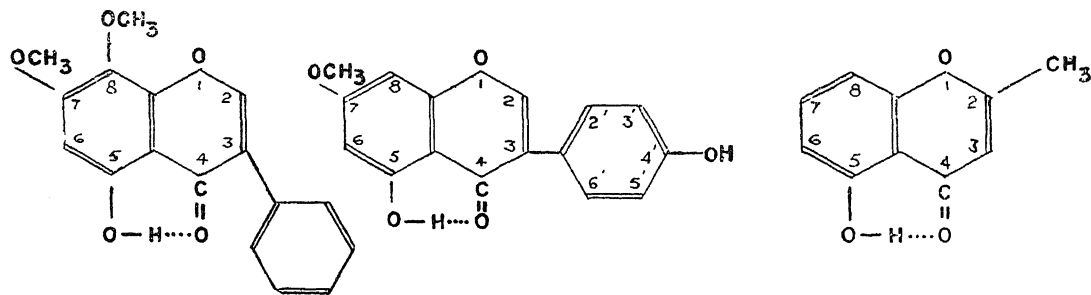
STUDIES IN TERPENES

Part XXI. On the Cyclisation of *dl*-Linalool with 20% Phosphoric Acid

IN view of its frequent occurrence in plants, linalool is considered to be the precursor of monocyclic terpenes.[1] This has prompted us, as part of our programme of research on the behaviour of various terpenes towards 20% phosphoric acid,[2] to examine the nature of monocyclic compounds derived by the action of this acid catalyst on *dl*-linalool.

1. Synthetic *dl*-linalool of 98-100% purity, kindly donated by Hoffmann la Roche, Inc., was used as the sample.

Reaction with 20% phosphoric acid.—A mixture of linalool (92·52 g., 0·6 mol.) and 20% phosphoric acid (58·8 g., 0·12 mol.) was refluxed together with stirring (magnet bar) for 20 hr. at 100-108° and work-up in the manner described earlier[2] furnished 82·2 g. of steam volatile oil, b.p. 165–88°/741 mm., n_D^{20} 1·4713, d_4^{25} 0·8996.

Fractionation of the oil.—A sample of the oil (36 g.) was fractionated at 741·4 mm. in Todd Assembly, using Monel Spiral Column at a reflux ratio of 25 : 1. The oil distilled as follows : (1) 165–69°, n_D^{20} 1·4581, 2·4% ; (2) 169–71°, n_D^{20} 1·4597, 1·4% ; (3) 171–73° n 1·4616, 3·7% ; (4) 173–75°, n_D^{20} 1·4626, 14·5% ; (5) 175–78°, n_D^{20} 1·4653, 20·8% ; (6) 178–81°, n_D^{20} 1·4706, 14·1% ; (7) 181–48°, n_D^{20} 1·4786, 10·3% ; (8) 184–88°, n_D^{20} 1·4827, 7·3% ; and (9) Residue n_D^{20} 1·4840, 14%.

Identification of Constituents[3]

1 : 8-Cineole.—Hydroferrocyanic acid complex[4] was obtained from fractions 1 to 6 (400 mg. each) in yields of *ca* 50 mg., 20 mg., 40 mg., 50 mg., 30 mg. and 5 mg. respectively. No resorcinol complex, however, could be prepared from any of these cuts.

Fractions 3 and 4 were mixed and 2·5 g. of this was shaken with 1% potassium permanganate in the cold until a permanent pink colour remained. The residual oil (*ca* 425 mg., n_D^{20} 1·4538) was recovered by steam distillation and its infrared spectrum compared favourably with that of authentic 1 : 8-cineole.

α-Terpinene.—From fraction 3 (300 mg.) only traces of α-terpinene nitrosite was obtained but fractions 4 and 5 (850 mg. each) yielded *ca* 20 mg. and 40 mg. respectively of the derivative, mixed m.p. with an authentic specimen of α-terpinene nitrosite, 155°.

Dipentene.—The bromination of fractions 5 and 6 (850 mg. each) furnished *ca* 300 mg. and 400 mg. respectively of dipentene tetrabromide,

m.p. and mixed m.p. with an authentic specimen of dipentene tetrabromide, 124°.

Terpinolene.—Yields of terpinolene tetrabromide from fractions 7 and 8 (850 mg. each) amounted to *ca* 200 mg. and 600 mg. respectively, m.p. 116°, not depressed by an authentic specimen of terpinolene tetrabromide.

α-Terpineol.—A mixture of ice-cold fraction 9 (4·7 g.) and 50% sulphuric acid (30·2 g.) was stirred vigorously (magnet bar) for 5 min. Added to this 25 ml. of chilled water, and stirred again for 5 min. The reaction mixture was refrigerated for 24 hr. and the crystals formed were collected by filtration (yield *ca* 10 mg.). On recrystallisation from hot water, the analytical product melted at 116–17°, undepressed by admixture with authentic *cis*-terpin hydrate.

p-Cymene.—The monocyclic fraction of the steam distillate b.p. < 190° (8·5 g.) afforded *ca* 850 mg. of saturated oil which yielded terphthalic acid on oxidation, indicating the presence of *p*-cymene in the oil.

Thus, when heated with 20% phosphoric acid for 20 hr. at 100–08°, *dl*-linalool gave a mixture of monocyclics which contained dipentene, terpinolene, α-terpinene, α-terpineol, 1 : 8-cineole and *p*-cymene.

Department of Chemistry,   K. K. SUGATHAN.*
Christian Medical College,   JAMES VERGHESE.
Vellore, N. Arcot., *October 5, 1964.*

* Present address : Department of Chemistry, Sree Kerala Varma College, Trichur.

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NEW TECTONIC FEATURES IN SECTIONS EAST OF GURYUL RAVINE, KHUNMU, KASHMIR

RECENT investigations of the palæontology, stratigraphy and tectonics of the Himalaya have led to some interesting results which have already been reported.[1-4] In the present note, the authors report fresh evidence regarding important tectonic features revealed by a study of the sections exposed east of Guryul ravine near Khunmu (Khunamuh), Kashmir (74° 57′ 15″ : 34° 03′ 30″), which divides the dip slopes of the Panjal volcanics and the sedimentary sequence,

the former occurring to the west and the latter to the east of the ravine. Towards the east is exposed a series of strata ranging in age from Upper Carboniferous to Trias. In so far as the Carbon-Trias sections of the Himalaya are concerned, this section is considered important as it reveals that the Trias is not totally absent in Kashmir as was believed before the work of Middlemiss.[5] This and the Zewan Permo-Carboniferous sections to the west were first discovered by Godwin-Austen[6] and were followed up by accounts given by Verchére,[7] Noetling[8] and Hayden.[9] Middlemiss (*op. cit.*) gave a detailed stratigraphic account of this section while dealing with the "*Gondwanas and Related Marine Sedimentary Systems of Kashmir.*" He regarded this section as a uniformly dipping conformable sequence, and stated (pp. 306–308) :—

That the section "*shows no sign of unconformity, no discordance of dip, and no rapid petrological changes .... and .... Contrary to what Verchére found in this section, I found no serious irregularities, refolding or faulting until well beyond the beds regarded as Muschelkalk.. whilst the question as to whether a fault should be located there has already been disposed of in the negative.*"

The field investigations undertaken by H. M. Verma provides clear evidence of structural disturbance on the spur (locally known as Hardalao) immediately east of Guryul ravine.

FIG. 1. Photograph of a symmetrical plunging anticline observed on the spur east of Guryul ravine. Camera facing N.E.

A tight, symmetrical isoclinal fold (anticline) with both limbs dipping 30° E.S.E. was observed

indicating strong disturbance in a section regarded by Middlemiss as a uniformly dipping sequence (Fig. 1). This disturbance occurs above Lower Triassic limestones ["Hor. (1)-(4) 6·8·08″ of Middlemiss] immediately above the intercalated black limestones and shales. The beds above these limestones form a dip-slope and dip straight into the stream bed east of Guryul ravine. The black limestones and shales are repeated on the eastern banks of this adjacent stream. The question whether the shales and limestones in these two adjacent exposures are repeated as a result of folding or faulting is being left open pending elucidation of further palæontological and structural details.

Department of Geology,   M. R. SAHNI.
Panjab University,   H. M. VERMA.
Chandigarh, *September* 24, 1964.

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NOTE ON THE OCCURRENCE OF *GLOBOROTALIA* IN NINIYUR STAGE, SOUTH INDIA*

THE note records the occurrence of the genus *Globorotalia* represented by *Globorotalia (Truncorotalia) mossæ* Hofker[1] in the Niniyur stage, Tiruchirapalli District, Madras. The *Globorotalia*-bearing sample comes from the *nala*-section about one kilometre east-north-east of Anandavadi (11° 11′ : 79° 10′ 30″) from a buff to cream-coloured fossiliferous marl bed, full of echinoid spines, five metres in thickness and about twenty metres above the base of the Niniyurs. The extension of the Niniyurs from Sendurai (11° 15′ : 79° 10′ 15″) southwards up to Anandavadi has already been reported by the authors.[2,3] They collected over thirty samples from Niniyur stage exposed east of Nanniyur (11° 16′ 15″ : 79° 10′ 45″), Sendurai and north-east of Anandavadi and studied for microfossils. The samples yielded very poor foraminiferal assemblages and only one sample from Anandavadi section contained *Globorotalia*. The following genera are noted :—

Foraminifera : *Anomalina, Cibicides, Globo-
rotalia, Quinqueloculina, Textularia* and
Triloculina.

Ostracoda : ? *Cytheris, Cytherella* and *Cythe-
relloidea.*

The Ariyalur stage, on which the Niniyur
stage conformably overlies, contains typical
Mæstrichtian foraminiferal assemblage in its
upper horizon. From these beds the authors
record the occurrence of *Globotruncana gansseri,
G. contusa, G. stuarti* and *G. arca.* The Niniyurs
are devoid of this assemblage and further
shows *Globorotalia* for the first time in these
formations.

The occurrence of *Globorotalia* in Niniyur
stage has considerable stratigraphic significance
in demarcating the Cretaceous-Tertiary boundary
in this region. The age of Niniyur stage has
been well established as Danian on palæonto-
logical evidences. But there has been some
doubt regarding assigning these beds to the
uppermost Cretaceous or lowermost Tertiary
horizon. Micropalæontological studies, else-
where in the world, have conclusively proved
the Tertiary aspect of the beds regarded as
Danian and favour including them in Paleocene.
Nagappa[4] has shown that in extra-peninsular
region the *Cardita beaumonti* beds, correlated
as equivalents of Danian, show similar forami-
niferal change with *Globigerina-Globorotalia*
assemblage. Thus it is evident that the *Globo-
rotalia*-bearing Niniyur beds of South India are
distinct from the Cretaceous and mark the
beginning of the Tertiary era.
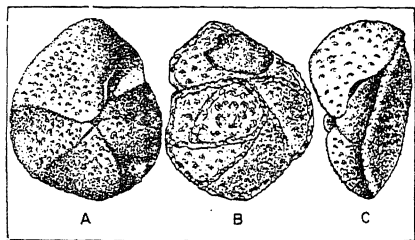
FIG. 1. *Globorotalia (Truncorotalia) mossæ* Hofker,
×55. A. Ventral view; B. Dorsal view; C. Side view.

DESCRIPTION

Globorotalia (Truncorotalia) mossæ Hofker
(Figs. A, B, C)

Test small, robust, wall calcareous perforate,
rugged with knobs which are more concentrated
in the umbilical region ; dorsal side elongate to
oval, flat ; ventral side convex, truncated,
chambers covering the umbilical region com-
pletely ; peripheral margin acute with crenulated
poreless border ; chambers angular, conical, five
on the ventral side increasing gradually in size
as added, on the dorsal side only five chambers
of the last whorl visible ; sutures depressed and
almost radial on the ventral side, oblique,
limbate and flush with the surface on the dorsal
side, limbation due to arrangement of knobs ;
aperture a long crescent-shaped slit along the
major part of the ventral suture.

Figured Specimen : G.S.I. Type No. 18126.

Central Palæontological   M. V. A. SASTRY.
    Laboratories,   B. R. J. RAO.
Geological Survey of India,   V. D. MAMGAIN.
Calcutta, *September* 28, 1964.

* Published with the kind permission of the Director-
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OCCURRENCE OF ACID MUCOPOLYSACCHARIDE IN THE CUTICLE OF SCORPION *PALAMNEUS SWAMMERDAMI*

ACID mucopolysaccharides have been reported
in the cuticle of crustaceans such as *Hemigrapsus
nudus,*[1] *Orconectus virilis,*[2] and in insects like
Calliboetis ferrugineus.[3] In *H. nudus* Meenakshi
and Scheer[1] following the methods of Bera
et al.[4] obtained in the alkali extract of the
cuticle an acid mucopolysaccharide which they
separated electrophoretically, while in *O. virilis*
the acid mucopolysaccharide was detected by
positive metachromasia in the endocuticle. In
C. ferrugineus[3] the subcuticular regions reacted
positively to alcian blue as well as to meta-
chromatic staining suggesting the occurrence of
acid mucopolysaccharide. Meenakshi and
Scheer[1] suggested that they may be involved
in the process of calcification of the cuticle.
In the following account evidences indicative
of the presence of acid mucopolysaccharide in
the cuticle of scorpion *Palamneus swam-
merdami* are reported.

In the inter moult cuticle of *P. swammerdami,*
the unhardened endocuticle reacted positively to
toluidine blue, staining purple while the tanned
exocuticle took up a green colour. The epicu-
ticle was not reactive. The purple colour deve-
loped in the endocuticle is suggestive of the
presence of acid mucopolysaccharide.[5-7] The

significance of the green colour in the tanned exocuticle is not clear although Travis[8] observed in spiny lobster, such a green colour in the regions which later show positive metachromasia. The acid mucopolysaccharide referred to in the scorpion cuticle may be extracted with 5% sodium hydroxide in 24 hours. After such treatment the cuticle ceased to stain with toluidine blue. Presumably the acid mucopolysaccharide is removed from the cuticle by alkali extraction.

To verify the nature of this material the alkali extract was analysed for acid mucopolysaccharides. For this purpose the extract was neutralised and zinc hydroxide followed by amyl alcohol chloroform mixture added to remove the protein. The polysaccharide was later precipitated using ethanol following the method of Rice[9] and analysed chromatographically according to the method of Hammerman.[10] The solvent used was 55% 0·05 M di-sodium hydrogen orthophosphate and 45% isopropyl alcohol. On developing with toluidine blue (prepared by dissolving 40 mg. in 80 ml. of acetone and 20 ml. of distilled water) a purple spot appeared on the paper indicating the presence of acid mucopolysaccharide.

The material obtained from alkali extract referred to above and shown to contain acid mucopolysaccharide was hydrolysed and its constituent sugars analysed chromatographically. The hydrolysis was carried out with 6 N HCl at 105° C. for 24 hours, and the hydrolysate spotted on Whatman No. 1 filter-paper. Circular chromatograms were run with Butanol-acetic acid-water (4 : 1 : 5)[11] and developed with silver nitrate (0·1 c.c. in 20 ml. of acetone) and sodium hydroxide (0·5 NaOH in 25 c.c. of rectified spirit) as suggested by Trevelyan et al.[12] The sugars identified from their Rf values are glucose, galactose and fucose. That the sugars mentioned above are derived from acid mucopolysaccharide has been verified as follows. The chitinous part of the cuticle obtained after separation of the epicuticle was hydrolysed and analysed chromatographically. The hydrolysate contained glucose, galactose and fucose. When the same material was extracted with alkali, as mentioned above and subsequently hydrolysed and analysed, only glucose was found to be present. These observations indicate that while glucose is the only sugar constituent of chitin the acid mucopolysaccharide contains glucose, galactose and fucose. In this respect it recalls the acid mucopolysaccharide described in the crustacean *H. nudus.*[1] The constituent sugars

of the acid mucopolysaccharide of *O. virilis* and *C. ferrugineus* are not known.

University Zoology Res. Lab.,   N. Krishnan.
University of Madras,
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UPWELLING OFF THE EAST COAST OF INDIA*

The presence of upwelling off the Central part of the east coast of India has been indicated by LaFond and others in a series of publications.[1-4] They base their evidence mainly on the distribution of parameters like temperature, salinity and density on the continenal shelf off the Central east coast, between the mouths of the Godavari and Kistna rivers in the south and of the Mahanadi in the north. According to these authors the evidence obtained so far conclusively establish the existence of upwelling along this coast from March to May. As a result of more extensive investigations in recent years and also in the light of modern developments in our ideas concerning oceanic phenomena such as upwelling, sinking, etc., it has been found that these observations require more critical reappraisal.

On a detailed examination of the data, it has been seen that the upwelling reported in this region (*i.e.*, off the coast of Waltair) differs considerably both in regard to the extent and in regard to other associated physico-chemical and biological conditions, from the classical upwelling regions of the world like off the coast of California, South-West Africa and so on. Also there is a marked difference between this

upwelling and that reported along the south-west coast of India (Arabian Sea). In the latter it has been seen that during the late south-west monsoon and early post-monsoon upwelling is fairly intense and the shelf is perveded by water which is cold, dense and saline, highly deoxygenated (values of oxygen less than $1 \cdot 0$ ml./L. occurring almost within 10 meters from the surface) and very rich in nutrients.[5,6] The biological and fishery productivity have also been shown to be very high in the west coast waters following the upwelling. Similar changes in the conditions have, however, not been seen in the waters off the east coast to any appreciable extent. It is possible that the upwelling observed by LaFond and others is a case of a very much localized phenomenon and also is too weak to exert any influence on a wider scale.

The author has had occasion to examine some of the data collected for the same area in the same period by the U.S. Research Vessel *Anton Bruun* during her recent cruises in the Bay of Bengal in connection with the International Indian Ocean Expedition. As a few stations were worked by this research vessel on the continental shelf off Visakhapatnam, it was felt that a careful examination of these data should reveal a clearer picture of the conditions. Another happy coincidence is that for the same period a line of five stations was occupied by INS KISTNA just outside the edge of the continental shelf between Madras and Visakhapatnam and as such these data were also available for studying in conjunction with the *Anton Bruun* data. Besides examination of temperature and salinity data both for surface waters and waters at the subsurface levels, a detailed study was made of the variations in the thickness of the upper mixed layers and the level of the oxygen-deficit layers. It may be mentioned here that during the period when there is intense upwelling it is usual for the low oxygen water to come up almost to the surface. From the available data it is seen that the oxygen-poor layer lies well below 50 meters in all the stations and in the stations close to the coast the oxygen is quite high down to the bottom. No temperature discontinuity is seen in the waters on the shelf and outside, the thermocline being well below 50 meters. There is thus no indication whatsoever of the existence of upwelling in the waters off this coast at this time of the year. It is worth mentioning in this connection that with the exception of the Somali-Arabian Coast, no marked upwellings have so far been recorded along the east coasts of continents elsewhere in

the northern hemisphere. This, however, does not rule out the possibility that upwellings can exist along east coasts of continents under certain special meteorological and oceanographical conditions. The only question is what are the special conditions that may have contributed to this upwelling off the Waltair coast as reported by LaFond and co-workers at the Andhra University. It is quite clear that more detailed investigations are necessary both on the shelf and in the offshore waters off the east coast of India for getting a proper answer to these questions.

Directorate of the   R. JAYARAMAN.
Indian Ocean Expedition (CSIR),
New Delhi-1, *January* 14, 1965.

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A NEW SPECIES OF *DEIGHTONIELLA* ON *ARTHRAXON LANCIFOLIUS* (TRIN.) HOCHST. FROM BHOPAL (INDIA)

IN the course of investigation of fungi causing leaf spot diseases at Bhopal the author collected a leaf spot disease of *Arthraxon lancifolius* (Trin.) Hochst. from the Botanical Garden, Motilal Vigyan Mahavidyalaya, Bhopal, on 17th September 1963.

The spots start as light brown dots but finally enlarge and become oval to elongated in the direction parallel to the veins. They are surrounded by a yellow halo. Two or more spots often coalesce together forming large irregular patches measuring upto $2 \cdot 5$ cm. in length. The midrib and other veins are freely traversed. Microscopic examination of the infected portions revealed an interesting species of *Deightoniella* having the following morphological characters.

Hyphæ repent, subhyaline to pale or golden-brown in colour, slender, septate and branched; conidiophores (Fig. 9) brown, erect, straight or curved, simple or branched, arising singly or in groups of 2–4, measuring 68–$327 \times 4 \cdot 8$–$7 \cdot 2 \, \mu$ (average $172 \times 6 \, \mu$), smooth except the sporogenous cell, 2–10 septate, basal cells swollen

8–13 μ in diameter, upper part cylindrical but with cupulate swellings (8·5–11 μ wide) marking the point of attachment of successive conidia. Single conidium (Fig. 9) developed acrogenously on apical sporogenous cell, upper half of the sporogenous cell invaginates after the conidium is shed and forms a double-walled apical cup (Fig. 1, 2). This part is paler and distinctly tuberculate. Conidia (Fig. 10) are golden-brown to brown, obclavate, 38–52 × 20–31 μ (average 43 × 26 μ excluding appendage), distoseptate,[3] mostly 3 septate (rarely 2–4 septate), second cell from the base is the largest and broadest, epispore golden-brown to brown and brittle, scar at the basal end indicates the point of attachment to the conidiophore. Apical cell of conidia bears a hyaline to subhyaline, simple, straight or slightly curved, 0–3 septate appendage measuring 35–100 μ (average 58 μ) in length. The terminal proliferation usually arises from the first septum below the tip of the conidio-phore after the conidium is shed. It grows inside the terminal cell and emerges by ruptur-ing the conidial scar (Figs. 3–6).
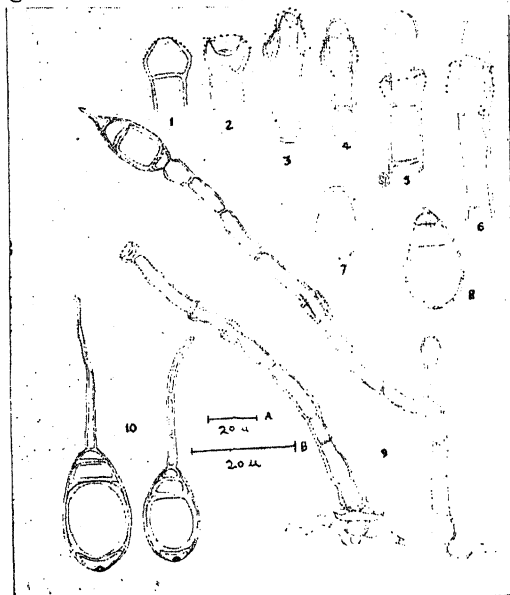
FIGS. 1–10. *Deightoniella bhopalensis.* Fig. 1. Sporo-genous cell showing pore in face view. Fig. 2. Sporogenous cell showing invaginated apical wall. Figs. 3–6. Conidio-phores in various stages of proliferation. Figs. 7–8. Imma-ture conidia. Fig. 9. Condiophores. Fig. 10. Mature conidia showing hilum in face view. Figs. 1–6 to scale B; Figs. 7–10 to scale A.

The present fungus differs from all other taxa classified in this genus[1-2,4] on account of the characteristic apical appendage of the conidia, their shape and size. The specimen was examined by Dr. Ellis who considers it to be an interesting new species of *Deightoniella.* It is, therefore, being described here as a new species, *Deightoniella bhopalensis* Satya.

Deightoniella bhopalensis SATYA, SP. NOV.

Hyphæ repentes, subhyalinæ vel pallide aureo-brunneæ, graciles, septatæ et ramosæ; conidiophora brunnea, erecta, recta vel curva, simplicia vel ramosa, emergentia singula vel fasciculata bina-quaterna, 68–327 × 4·8–7·2 μ (mediet. 172 × 6 μ), levia præter cellulam sporogenam, 2–10 septata, cellulis basalibus tumescentibus, 8–13 μ diam., parte superiore cylindrica sed tumescentiis cupulatis notata (8·5–11 μ latis) quæ punctum signant unionis conidiorum successivorum. Conidia acrogene evoluta cellulis apicalbus sporogenis insidentia, dimidio superiore cellulæ sporogenæ invagi-nante post conidii lapsum et efformante cyathium apicale. Hæc pars pallidior et distincte tuber-culata. Conidia aureo-brunnea vel simpliciter brunnea, obclavata, 38–52 × 20–31 μ (mediet. 43 × 26 μ appendice exclusa), distoseptata, vulgo 3-septata (rarius 2–4 septata), cellula secunda a basi est omnium maxima at latissima, episporio aureo-brunneo vel brunneo et fragili, cicatrice ad apicem basalem monstrante punctum unionis cum conidiophoro. Cellula apicalis conidiorum appendicem portat hyalinam vel subhyalinam, simplicem, rectam, vel curvam, 0–3 septatam, 35–100 (mediet. 58 μ) longam. Conidiophora proliferant successive ex septo primo infra apicem conidiophori post lapsum conidii. Pro-liferatio crescit interior in cellula terminali et emergit per fracturam cicatricis conidialis.

In foliis viventibus *Arthraxonis lancifolii* leg. H.N.S. die 17 septembris anni 1963; typus positus in C.M.I., Kew, sub numero IMI 102498.

The type specimen has been deposited at C.M.I., Kew, London, as No. IMI 102498. The author expresses his grateful thanks to Dr. R. N. Tandon, Department of Botany, University of Allahabad, for helpful suggestions, to Principal Dr. M. S. Rao and Prof. O. N. Handoo for facilities. Thanks are also due to Dr. M. B. Ellis of C.M.I., Kew, for help in the identification of the species and to Dr. H. Santapau for Latin diagnosis.

Pathology Section,   H. N. SATYA.
Department of Botany,
M. V. Mahavidyalaya,
Bhopal, *May* 22, 1964.

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SOME INTERESTING OBSERVATIONS ON *GLOEOCYSTIS AMPLA* KUETZ. GROWN IN UNIALGAL CULTURE

THE present alga was observed in an enrichment culture of soil collected from the paddy fields of Ballia District, U.P., India. The enrichment cultures were prepared by adding a little of soil in De's[1] medium in the sterilized petri-dishes, which were incubated in a culture chamber, illuminated with a fluorescent electric tube (light intensity approximately 100 lux near the culture dishes). The alga grew as isolated, bright green colonies at the bottom among soil particles and also on the scum of the fluid after a lapse of about three months. Since this alga has not been subjected to detailed investigation under cultural conditions it was thought desirable to execute such a study.

The alga, when cultured by the method reported earlier,[2] thrived luxuriantly on agar slants or in liquid De's medium. The growth response was considerably enhanced in liquid medium as compared to the soild substrate.

In culture, the colonies were spherical or globular (Figs. 1 and 2) of smaller or larger

FIGS. 1–6. *Gloeocystis ampla* Kuetz. Fig. 1. A young colony. Fig. 2. A young colony magnified to show chlamydomonad cells. Fig. 3. An old colony showing irregular margin and pouch-like projections. Fig. 4. A portion of an old colony magnified to show the presence of sheath and multiplication of cells. Fig. 5. A marginal portion of an old colony to show overlopping pouch-like projections and chlamydomonad cells. Fig. 6. Biflagellate swarmers.

dimensions, usually varying from 100–700 μ in diameter. Older colonies on agar slants become somewhat irregular in shape and outline and measure up to 4 mm. or more in diameter. The colonies are formed of a number of chlamydomonad cells which are deviod of any flagella. The cells are ovoid or oblong but occasionally they may be somewhat spherical. They possess a cup-shaped paretal chloroplast with a centrally placed pyrenoid and two contractile vacuoles towards the apex (Figs. 2 and 5).

As the age advances, the sheath around the individual cells becomes distinct (Fig. 4). Among stains, it gives excellent response to dilute Gentian-violet but stains only faintly with ruthenium red. Further growth results due to multiplication of cells within the individual sheath. The daughter cells thus formed usually emerge in 2- or 4-celled groups enclosed within the sheath of the parent colony (Fig. 4). In many cases, the outline of sheath of the daughter colonies becomes angular due to mutual pressure. Still later, the sheath of the parental colony either ruptures at one or more places or becomes irregularly distended (Fig. 3). The groups now appear as pouches somewhat overlapping each other and some projecting out beyond the sheath of the parent colony (Fig. 5). Due to irregular rupture of the sheath of the parent colony, the daughter colonies (pouches) are liberated and thus aid the propagation.

Induced production of swarmers could be achieved by transferring the alga from solid medium to sterile tap-water and leaving it overnight under complete darkness. The swarmers are chlamydomonad (Fig. 6), possess a cup-shaped parietal chloroplast, a pyrenoid, two contractile vacuoles, two equal flagella but lack a stigma. The swarmers are usually ovoid with a narrower apex and a small anterior papilla. They are 4.5–$6.5\,\mu$ in diameter and 6.5–$9.5\,\mu$ in length. The flagella are 8–$9.5\,\mu$ long. After swimming for some time, the swarmers settle down at the bottom of the fluid, withdraw their flagella and secrete to a wall and become globular.

The author expresses his indebtedness to Dr. A. K. Mitra, for supervision during the course of this investigation.

Dept. of Botany,   DEVESH CHANDRA PANDEY.
The University, Allahabad-2,
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CULTURE OF TWO SCHIZOGREGA-RINES, *FARINOCYSTIS TRIBOLII* WEISER AND *MATTESIA DISPORA* NAVILLE *IN VITRO*

Not much work seems to have been done on the *in vitro* study of the protozoans affecting the invertebrates. Only work in the line had been that of Trager[1] who obtained partial development of amœbuli of *Nosema bombycis* Naegeli to planonts in the tissue culture of *Bombyx mori* L. Sen Gupta[2] recently described the development of a microsporidian, *Nosema*

mesnili Paillot in the tissue cultures of *Pieris brassicœ* L. The present communication describes the development of two schizogregarines *Farinocystis tribolii* Weiser and *Mattesia dispora* Naville in the tissue cultures of *Tribolium casteneum* Hbst. and *Galleria mellonella* L. (alternate host, original host being *Ephestia kühniella* Zeller) respectively.

In both cases the medium modified Trager's D_4[3] was used and the tissues incubated at 26° C.

With *F. tribolii* the experimental insects were orally infected through a meal of flour contain-
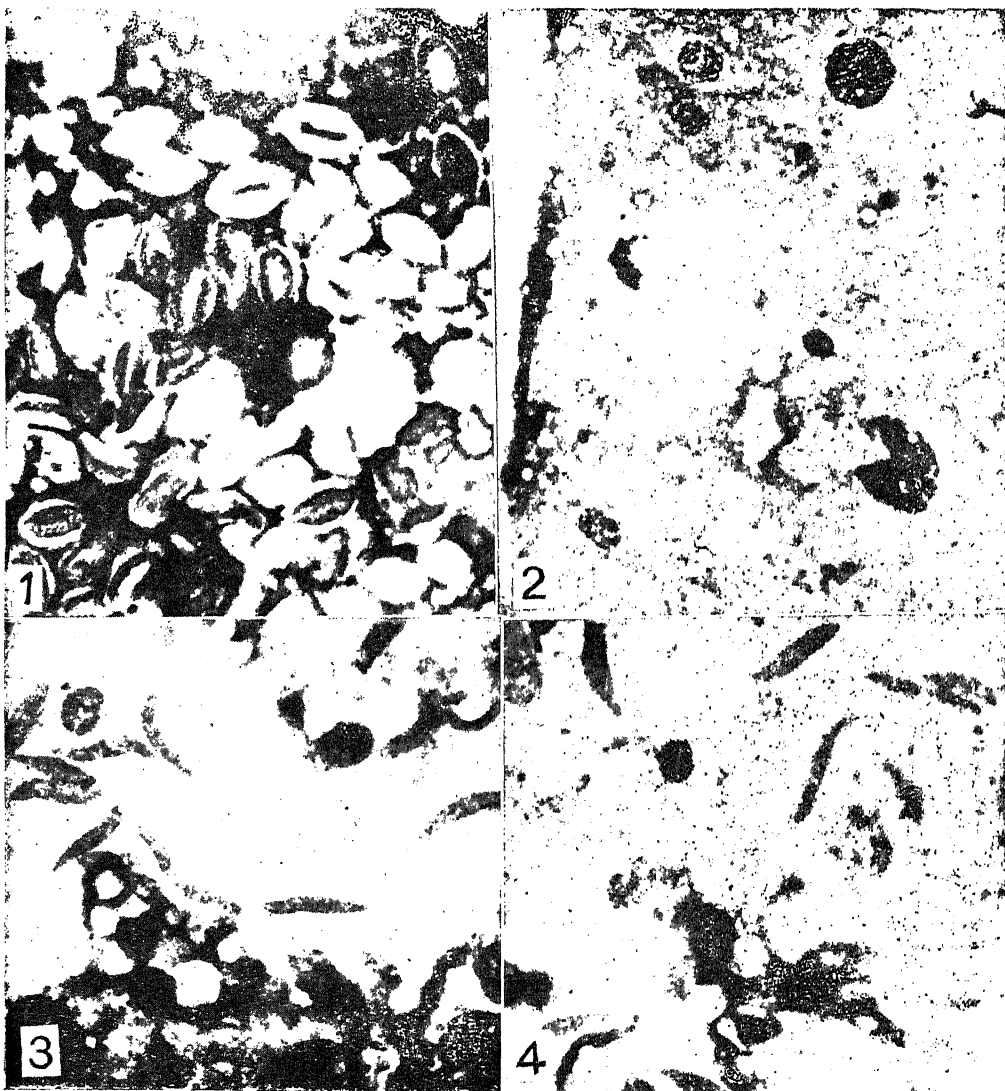
FIGS. 1–4. Figs 1-2. Conditions of the fat body from *T. casteneum* in tissue culture after infection with *F. tribolii*. Fig. 1. At the time of explantation containing spores. Fig. 2. On the second day containing sporozoites. Figs. 3-4. Conditions of the fat body from *G. mellonella* in tissue culture after infection with *M. dispora*: Fig. 3. Just after infection showing mainly gregarinoid schizonts. Fig. 4. On the twelfth day showing spores and schizonts.

ing *F. tribolii* oocysts and reared normally for
a day. On the second day the insects were
dissected and the tissues, gut and fat bodies
were put in the roller tubes containing the
medium. The cultures were set to rotate at
12 r.p.h. in the incubator.

At the time of setting the cultures mostly
spores were found (Fig. 1). During culture *in
vitro* their development went on, showing
gradually in the culture various stages. By
second to fourth day sporozoites were visible
(Fig. 2). By eighth to the tenth day schizonts
were found. The parasites were also found to
affect the newly growing cells.

With *M. dispora* the cultures were infected in
two steps. In the first step second instar larvæ
of *G. mellonella* (alternate host) were infected
per-orally by the infecting material, *viz.*, spore-
suspension from *E. kühniella* (original host) and
were kept for normal rearing for about ten days
by which time the blood of infected *G. mellonella*
was full of schizonts. In the second step the
set tissue cultures were infected with hæmo-
lymph from the infected *G. mellonella* in Petri
dishes. The cultures were incubated for sixteen
days. The development of the parasite was
followed by taking samples of hæmolymph and
fat bodies (the tissues used for culture) from
the culture medium.

The infecting material contained mainly gre-
garinoid schizonts (Fig. 3). On the fourth day
following infection was found the multiplication
of schizonts. By the sixth day were found
schizonts and gamonts (gametocytes). By the
tenth day were found schizonts, some gametes
and spores. By the twelfth day were found
spores and schizonts in degenerating condition
(Fig. 4). By the sixteenth day were found
mostly spores. Size, shape and form of the
parasite at different stages of development were
similar to those grown *in vivo*.

Thanks are due to Dr. S. Krishnaswami,
Director of Research, Central Sericultural
Research Station, Berhampore, West Bengal, for
his valuable suggestions in the preparation of
the paper.

Institute of Biology,　　　　　K. SEN GUPTA.*
Czechoslovak Academy of
　Science,
Prague, Czechoslovakia,
August 17, 1964.

1. Trager, W., *J. Parasitol.*, 1937, **23**, 226.
2. Sen Gupta, K., *Curr. Sci.*, 1964, **33**, 407.
3. —, *Folia Biologica*, 1961, **7**, 460.

RICCIA GROLLEI UDAR NOM. NOV.—A CORRECTION FOR *RICCIA TUBERCULATA* PANDÉ *ET* UDAR FROM INDIA

A NEW species of *Riccia*, *R. tuberculata* Pandé
et Udar, was described by Pandé and Udar (1958)
on the basis of specimens collected from
Runnymede, Madras State, South India.
Recently Dr. Riclef Grolle (Institut für Spezielle
Batanik, Jena, Germany, D.D.R.), in a personal
communication drew my attention that *R. tuber-
culata* Pandé *et* Udar is a 'later homonym' of *R.
tuberculata* Lamarck *et* Poiret necessitating the
typification of the Indian taxon by a new name.

Müller (1952) places *R. tuberculata* Lamarck
et Poiret as a possible synonym of *Riccia glauca*
Linné (although accrediting the species only to
Lamarck). Such a preference for the status
of *R. tuberculata* Lamarck *et* Poiret clearly
leaves the Indian *R. tuberculata* Pandé *et* Udar
as a distinct taxon in view of its considerable
difference with *R. glauca* Linné.

Riccia grollei Udar nom. nov. is proposed here
for the reception of *R. tuberculata* Pandé *et*
Udar. The new specific epithet stems after
Dr. R. Grolle who first pointed out the untena-
bility of the name *R. tuberculata* Pandé *et* Udar
to me. The following nomenclatural status
including the Latin diagnosis is given here to
legitimatize the new name.

Riccia grollei UDAR NOM. NOV.

[Syn. : *Riccia tuberculata* Pandé *et* Udar in
Proc. nat. Inst. Sci. (India) 24 B: 79-88,
1958, non *Riccia tuberculata* Lamarck *et*
Poiret in *Encyl. Method. Botan.* 6 : 199, 1804].
Monoica, glauco-virens ; frons ad 5 mm. longa,
ad 2 mm. lata, simplex vel bifurcata, lateribus
ascendentibus, marginibus acutis, sulcus ad
apicem profundus et acutus ; squamæ magnæ,
integræ, imbricatæ, atro-purpureæ, marginem
superantes ; sporæ 80-110 *µ*, brunneæ, conferte
papillatæ et irregulariter lamellataæ, ad angulos
papillatæ, facies internæ plus minusve regula-
riter lamellatæ ; anguste alatæ, margo alæ
papillatæ, 6·6 *µ*.

Coll. Pandé and Srivastava. Loc. : Runnymede,
Madras State, South India. Habitat : Growing
on red soil. Date : October 6, 1950. Pandé
Collection No. 3803, Lucknow University.
(Latin diagnosis after Pandé *et* Udar, 1958).

Department of Botany,　　　　　RAM UDAR.
University of Lucknow,
Lucknow (India), *November 25, 1964.*

1. Pandé, S. K. and Udar, R., *Proc. nat. Inst. Sci.
　　India*, 1958, **24 B**, 79.
2. Müller, K.. "Die Lebermoose," in *Rabenhorst's
　　Cryptogamen Flora*, 1952 **6** (1), 469.

NEW COMBINATIONS IN THE POLYPODIACEAE

IN course of our investigation into the cyto-taxonomy of the family Polypodiaceæ (sensu stricto) in Eastern India, a study of literature on the subject necessitated the making of the following new combinations in the two genera, viz., Pleopeltis and Belvisia. Comments on the taxonomic treatments of the different species and important notes on their habits, habitat and distribution have been appended to every species. *Pleopeltis caudato-attenuata* (Takeda) Panigr. et Patn., *P. subconfluens* (Ching) Panigr. et Patn., *P. pseudonuda* (Ching) Panigr. et Patn., *P. sordida* (C. Chr.) Panigr. et Patn. have been reported here as new records for India.
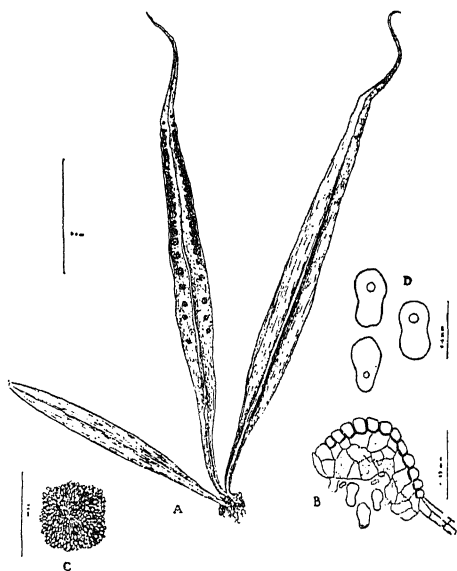
FIG. 1. *Pleopeltis pseudonuda* (Ching) Panigr. & Patn comb nov. A. Habit; B. Sporangium showing annulus and bad spores of different sizes; C. sorus; D. spores of different shape.

Pleopeltis caudato-attenuata (Takeda) Panigr. et Patn. comb. nov. Basionym—*Polypodium lineare* var. *thunbergiana* f. *caudato-attenuata* Takeda, *Notes Bot. Gard. Edinb.*, 8, 269, 1915. Synonym—*Polypodium caudato-attenuatum* (Takeda) C. Chr. *Ind. Suppl. III*, 146, 1934. *Lepisorus angustus* Ching, *Bull. Fan Mem. Inst. Biol.*, 4, 86, 1933.

In conformity with the International rules, Christensen raised forma *caudato-attenuata* Takeda to a species status and cited *Lepisorus angustus* Ching as synonymous to *Polypodium caudato-attenuatum* (Takeda) C. Chr. Since the various species of *Lepisorus* are now trans-

ferred to *Pleopeltis*, the new combination proposed here is necessary.

P. caudato-attenuata (Takeda) Comb. nov. collected from Tinchha-Laju Sector (1700 m.) (cf. *Panigrahi* 14965) in Tirap F.D., NEFA, is a new record of species for India, the earlier reports of its distribution being from China only. It is nearest to *Pleopeltis subconfluens* (= *Lepisorus subconfluens*) in habit, differing, however, in thinner texture and distinct sori.

Pleopeltis subconfluens (Ching) Panigr. et Patn. comb. nov. Basionym—*Lepisorus subconfluens* Ching, *Bull. Fan Mem. Inst. Biol.*, 4, 85, 1933. *Polypodium neurodioides* C. Chr. var. 4. C. Chr. *Contr. U.S. Nat. Herb.* 26, 319, 1931.

Christensen (1931) included under *Polypodium neurodiodes* C. Chr. 4 varieties which Ching (1933) refers to 4 distinct species under the genus *Lepisorus*. He has, therefore, proposed a new specific epithet, *L. subconfluens* Ching for Christensen's 4th variety—a procedure which seems to us justified. Accordingly, a new combination with *Pleopeltis* as above is proposed. Our collection from Kameng Frontier Division, NEFA (*Panigrahi-*) and from Khasia Hills (*Panigrahi* 24454) establish this species as a new record for India.

Pleopeltis pseudonuda (Ching) Panigr. and Patn. comb. nov. Basionym—*Lepisorus pseudonudus* Ching, *Bull. Fan Mem. Inst. Biol.*, 4, 83, 1933.

The taxonomic status of this "species" which possesses $2n = 39$ in root tips and is characterised by gross meiotic irregularities and formation of bad shrunken spores (*see* Fig. 1, A-D) [Panigrahi and Patnaik, 1964 (in press)] is yet to be determined. This species, reported from Burma and China by Ching, has since been collected from Khasi Hills, Tirap F.D. and Kameng F.D. of NEFA on 4 different occasions. This is, therefore, a new report from India.

Pleopeltis sordida (C. Chr.) Panigr. and Patn. comb. nov. Basionym—*Polypodium sordidum* C. Chr. *Contr. U.S. Nat. Herb.*, 26, 320, 1931. Synonym—*Lepisorus sordidus* (C. Chr.) Ching, *Bull. Fan Mem. Inst. Biol.*, 4, 79, 1933.

This species reported by Ching from Burma and China has been collected by us from Laju (1600 m.) in Tirap F.D. of NEFA (vide *Panigrahi* 14724). This is, therefore, a new record of species for India.

Belvisia henryi (Hier. ex C. Chr.) Panigr. and Patn. comb. nov. Basionym—*Hymenolepis henryi* Hier. ex C. Chr. *Dansk Bot. Arch.*, 6, 67, 1929.

Christensen (*l.c.*) assigns "India boreal" distribution to this species. Collections from

Raliang in Assam (*Deka 5108*), Subansiri F.D. (*Subba Rao 24792*) and Siang F.D. (*Rolla 17854*) are the first definite records of the species for India.

Grateful thanks are due to the Council of Scientific and Industrial Research, New Delhi, for financial assistance and for the award of a Research Fellowship to the junior author. Thanks are also due to the authorities of the Kew Herbarium, England, for confirmation of identification of species dealt with here.

Botanical Survey of India,   G. PANIGRAHI.
Central Circle,   S. N. PATNAIK.
Allahabad, *September 9, 1964.*

GENOME CONSTITUTION OF ORYZA MALAMPUZHAENSIS KRISHN. ET CHANDRA

Oryza malampuzhœnsis ($2n = 48$) was reported by Krishnaswami and Chandrasekharan (1958). The species which is restricted in its distribution to Western Ghats of South India is different from the only other species of the series *Latifoliœ* occurring in India, namely, *O. officinalis* Wall *ex* Watt. in morphology as well as in ploidy. Gopalakrishnan (1962) secured a hybrid between these two species and reported that they share one genome (C) in common. Kihara (1963) studied the meiosis in F_1 hybrid *O. malampuzhœnsis* × *O. latifolia* and reported the occurrence of 12 bivalents confirming the similarity of one genome (C) in both the tetraploid species.

With the object of determining genome constitiution of *O. malampuzhœnsis*, the following two new records of interspecific hybrids were obtained :—

(i) *O. minuta* × *O. malampuzhœnsis* and reciprocal ($2n = 48$; pollen sterility 92·7%; spikelet sterility—nearly complete). F_1 hybrid resembled *O. minuta* in procumbent growth habit, stiffness of culm, prominent pulvinus and insensitivity to photoperiod. Fringing of ligules (of *O. malampuzhœnsis*) was partially dominant. In quantitative characters, the F_1 was intermediate between the parents. Meiosis in F_1 hybrid was fairly normal with 24_1s in 42 out of 55 PMCs observed. Mean chromosome pairing in the hybrids was $0·9_{iv} + 23·5_{ii} + 0·5_i$. It may therefore be concluded that the genomic constitution of the parents is similar.

(ii) *O. schweinfurthiana* × *O. malampuzhœnsis* and reciprocal ($2n = 48$; pollen sterility 96·5%; spikelet fertility—nearly complete). Although F_1 hybrids were exceedingly similar to *O. schweinfurthiana*, these could be distinguished by the frniging of leaf-sheath (of *O. malampuzhœnsis*) which is dominant and sterility. F_1 plants resembled *O. schweinfurthiana* in height, thickness of culm, shape of ligule and colour of stigma and anther.

Meiosis in the F_1 hybrid was compartively more irregular than in the former hybrid. In 5 out of 77 PMCs examined 24_{ii} were observed. In others, varying number of univalents, 2–24 were observed. Rarely hexavalents and quadrivalents were observed. Mean chromosome pairing in the hybrid was $0·01_{vi} + 0·36_{iv} + 19·2_{ii} + 8·1_i$. From the maximum potential pairing of 24_{ii}, it can be concluded that the genomes of the two species are similar.

Since *O. minuta* and *O. schweinfurthiana* are known to be tetraploid species with BBCC genomes, it can be concluded that the genomic constitution of *O. malampuzhœnsis* is also BBCC.

Tateoka (1963) considers *O. malampuzhœnsis* to be a subspecies of *O. officinalis*. This view seems to be not justified both on morphological grounds as well as on the present data on genome analysis. Morphologically, *O. malampuzhœnsis* is as distinct from *O. officinalis* as *O. minuta* is where such separation was justified (Tateoka, 1963 ; Tateoka and Pancho, 1963). Cytologically, *O. malapuzhœnsis* cannot be considered as a chromosome race of *O. officinalis* since it has two different genomes only one of which is common to *O. officinalis*. It is therefore suggested that *O. malampuzhœnsis* is a valid species deserving a specific rank.

Division of Botany,   R. GOPALAKRISHNAN.
Indian Agricultural   S. D. SHARMA.
Research Institute,   S. V. S. SHASTRY.
New Delhi-12, *December 17, 1964.*

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2. Kihara, H., 'Genome analysis in *Oryza*," 10th Pacific Sci. Congr., Honolulu, Hawaii, published in *Internat. Rice. Comm. Newsletter*, special issue, 1963, p. 57.
3. Krishnaswami, N. and Chandrasekharan, P., "A new species of *Oryza* I.," *Madras Agri. J.*, 1958, 45, 471.
4. Tateoka, T., "Taxonmic studies of the genus *Oryza*," *Symp. Rice Genet. and Cytogenet.*, Los Banos, Laguna, Philippine, 1963.
5. — and Pa·cho. T. V., "A cytotaxonomic study of *Oryza minuta* and *O. officinalis*," *Bot. Mag. Tokuyo*, 1963, 76, 366.

REVIEWS AND NOTICES OF BOOKS

The Macromolecular Chemistry of Gelatin ; Vol. 5—*An International Series of Monographs and Text-Books on Molecular Biology.* By Arthus Veis. (Academic Press, Inc., New York), 1964. Pp. 433. Price $ 14.50.

Gelatin is a manfuactured product with a long history of worldwide general use. New insignt into the properties of gelatin has been gained by reason of the recent advances in our knowledge of the structure of collagen which is the basic biological product which is transformed to gelatin in the process of its manufacture. Quite appropriately, therefore, the first chapter of the volume under review deals with the chemical composition of collagen, its structural characteristics and physical properties, before passing to consider the collagen-gelatin transition. The subsequent chapters deal with the molecular characterisation of gelatin, the conversion of collagen to gelatin, the degradation of gelatin and the gelatin-collagen transition.

In view of the great importance of gelatin as a basic product in many industries, this volume which handles the subject of its constitution and properties on a high scientific level will be warmly welcomed by a wide circle of readers.

C. V. R.

Stereochemistry. By J. Grundy. (Butterworth & Co., 88, Kingsway, London, W.C. 2), 1964. Pp. 227. Price 35 *sh.*

This book is a presentation of the theoretical aspects of stereochemistry and is intended as a text-book for students of organic chemistry, as well as those working in related disciplines. The subject is dealt with in ten chapters. The first three discuss the factors affecting atomic and molecular geometry. The fourth chapter deals with stereoisomerism generally. The fiftn, sixth, seventh and eighth discuss optical stereoisomerism in various classes of molecules. The ninth chapter discusses *cis-trans* isomerism and the tenth reviews the classification of stereoisomers. Useful discussions are found in the book of the most suitable way of representing molecular geometry in three dimensions by two-dimensional diagrams.

C. V. R.

Natural Organic Macromolecules. By B. Jirgensons. (Pergamon Press, London), 1962. Pp. x + 464. Price $ 16.00.

In recent years, the study of large molecules, particularly in the field of Organic Chemistry, has expanded by leaps and bounds, both because of their technical importance on the one side and because of their importance in relation to living systems on the other. The book under review deals essentially with the latter aspect of the subject. The author discusses not only materials like proteins and nucleic acids which are the essential constituents of living systems, but also other materials like polysaccharides and rubber and similar polyisoprenes which are the products of biological systems. The book is quite comprehensive in its scope, although because of this each topic is discussed only in limited detail.

The book is divided into three parts. Part I deals mainly with the methods of study employed in the study of biological macromolecules. This part is about a hundred pages in length and naturally only the essential principles are mentioned. For example X-ray diffraction is dealt with in ten pages, within which only some of the results of protein crystallography are mentioned. The reviewer feels that it would have been better if a few references had been given to standard books on the subject in which more information is available on the methods.

The second part deals with the various types of biological polymers and starts with materials like rubber and polysaccharides such as cellullose, starch, glycogen, pectins and others. Proteins are dealt with in particular detail and various topics such as the configuration of native and denatured proteins, hæmoglobins and other respiratory proteins, enzymes, hormones, nucleoproteins, histones, etc., are discussed in full detail. The fibrous proteins are discussed in a separate chapter and so are the nucleic acids. The discussion is in general quite satisfactory, although it is strange to read such misleading statements as the one on collagen saying that its triple helical structure was concluded by light scattering, "as deduced also from X-ray diffraction data".

The third part deals with bi for example viruses, biological r muscle, connective tissr

is extremely informative and contains a large number of references.

There is no doubt that the author has succeeded in bringing into one comprehensive volume all the different aspects of research dealing with the structure of biological macromolecules. The book will be found to be very useful by the non-specialist and particularly by medical and biological workers.

G. N. RAMACHANDRAN.

Advances in Cancer Research (Vol. 8). Editors : Alexander Haddow and Sidney Weinhouse (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York), Pp. 482. Price $ 17.00.

A major article in the present volume of *Advances in Cancer Research* is the one on "Experimental Tobacco Carcinogenesis" by E. L. Wynder and D. Hoffman of the Division of Environmental Carcinogenesis, Sloan-Kettering Institute for Cancer Research, New York, who themselves have made significant contributions to the subject. The article reviews the progress made in the field of tobacco carcinogenesis during the past decade (1953-63). The reason for the extraordinary interest evinced in this problem in cancer research centres all over the world is not far to seek. Cigarette smoking has been closely associated with incidence of lung cancer. A recent report on smoking as a cause of lung cancer states "that the magnitude of the effect of cigarette smoking far outweighs all other factors related to this disease" (U.S. Health Serv. Publ. No. 1103, 1964). Since complete stopping of the human smoking habit is out of question the only promising approach to the problem is to make smoking as "safe" as possible. This could be done by researches on the tumorigenic activity of tobacco and tobacco products. The article reviews biological and chemical studies involving tumorigenic and cilia-toxic activity of tobacco products, fractions and single components, analytical techniques employed and some fundamental aspects of tumorigenesis.

Another article of even greater importance is the one on carcinogenesis related to foods contaminated by processing and fungal metabolites. Food consumed by man or feeds given to farm animals represent substrates or carriers for toxic and carcinogenic agents and therefore represent major environmental sources for mediation of cancer through diet. The article by H. F. Kraybill and M. B. Shimkin reviews the latest developments in this field of study.

The other articles included in this volume are : The structure of tumour viruses and bearing on their relation to viruses in general by A. F. Howaston ; Nuclear proteins of neoplastic cells by H. Busch and W. J. Steele ; Nucleolar chromosomes : structures, interactions and perspectives by M. J. Kopac and G. Mateyko.

A. S.

New Dover Reprints in Physics :

Quantum Mechanics. By H. A. Kramers. $ 2.75.

Wave Mechanics and Its Applications. By N. F. Mott and I. N. Sneddon. Price $ 2.25.

Piezoelectricity (in two volumes). By W. G. Cady. Price $ 2.50. each.

(Dover Publications, Inc., 180 Varick St., New York 14, N.Y.).

The two well-known books on quantum mechanics have been serving since their publication as very useful text-books on the subject for students of physics and chemistry. Kramer's book, as D.ter Haar who has done the English translation says, "still represents the best available exposition of quantum theory. It is a unified treatment presenting the physical points of view of the quantum theory. The book is divided into two parts. The first of five chapters gives a thorough introduction to the foundations of quantum theory and how the classical mechanics of point particles can be generalised into a consistent quantum mechanics. The second part deals with extensions of quantum mechanics useful to problems of atomic and molecular structure, electron spin, Pauli principle, and radiation theory. Mott and Sneddon's *Wave Mechanics* emphasis in the treatment is on application of wave mechanics to facts of experiments.

Cady's book is a revised and enlarged version of the well-known single volume work on Piezoelectricity, first published in 1946. The revision for the Dover edition has been done by the author himself, and includes an Appendix and notes and references to some of the developments in recent years. The book brings together in a systematic manner the principles of piezoelectricity and of the related branches of science and technology including the historical background. A new feature of the present edition is the problems given at the end.

A. S.

An Introduction to Plasma Physics. By W. B. Thompson. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A.), 1963. Pp. viii + 266. Price $ 10.00.

The subject of plasma physics has been arousing such great interest in contemporary research and technology that there is keenly felt a need for an introductory book on the subject, especially the fundamental and theoretical aspects of it, which will be useful as a teaching guide to advanced students of physics and mathematics in colleges. The book by Dr. Thompson is an attempt to serve this purpose. It is based on the lectures given by the author at the Clarendon Laboratory of Oxford University and to the Department of Theoretical Physics, Imperial College, London.

The author in his approach to the subject is chiefly concerned with an idealized plasma composed of electrons and ions in which inelastic processes including ionization and recombination have assumed secondary importance. The treatment is formal, theoretical and comprehensive. There are three chapters on magnetohydrodynamics which deal with magnetic confinement of plasma, shock waves, and plasma stability. Kinetic theory of the plasma is a major chapter in the book and it deals with transport equations and their solution, Fokker-Planck equation, electromagnetic response, and the theory of collisionless plasma.

As an introduction to the modern theory of plasma dynamics the book will be welcomed.

A. S. G.

The undermentioned books belong to the well-known series produced by Dover Publications, Inc., of New York, which are intended to make scientific treatises of merit available to a wide circle of readers in an excellently produced form but at a modest price. They are listed below with brief notes regarding their authorship, contents and prices.

Physics of the Air. By W. J. Humphreys, Pp. 676. Price $ 3.00.

The excellence of this book will be evident from the fact that though originally published in 1920, it was revised again in 1929 and 1940. For over twenty years, Humphrey's work has been a standard text-book in physical meteorology. Its reprinting will be warmly welcomed.

The Chemistry of Uranium—*The Element, Its Binary and Related Compounds.* By Joseph J. Katz and Eugene Rabinowitch, Pp. 609. Price $ 2.95.

This book was originally published in 1951 and is still a complete and up-to-date compilation of information. The present volume is an unabridged reprinting of the 1951 edition. The book contains numerous bibliographical references, charts and figures which greatly add to its value.

Theory of Thermal Convection, with Special Application to the Earth's Planetary Atmosphere. Edited by Barry Saltzman, Pp. 461. Price $ 3.00.

This is an indispensable volume for anyone interested in the motions of the earth's atmosphere. It is a collection of 25 basic theoretical papers on thermal convection by the foremost authorities in the field: Helmholtz, Oberbeck, Jeffreys, Rayleigh, G. I. Taylor, S. Chandrasekhar, A. R. Low, C. G. Rossby, T. V. Davies, J. G. Charney, E. T. Eady, R. Fjørtoft, N. A. Phillips, and others. Students and research workers will find that the book contains most of what is necessary for a basic understanding of the theory of convection.

The Theory of Group Representations. By Francis D. Murnaghan, Pp. 369. Price $ 2.35.

This book is a comprehensive introduction to the theory of group representations. The author devotes particular attention to those groups which have proved to be of fundamental significance for quantum mechanics, especially nuclear physics. Since the usual representations of groups are groups of matrices, this work is also a valuable contribution to the literature on matrices.

Operational Methods in Aplied Mathematics. By H. S. Carslaw and J. C. Jaeger, Pp. 356. Price $ 2.25.

The object of this book is to describe the application of the Laplace Transformation to differential equations, a simple and effective substitute for more difficult and obscure operational methods. Easily understood and quickly learned, the principles and techniques of this method will be of vital interest to engineers and to all workers in applied mathematics.

Introduction to Non-Linear Differential and Integral Equations. By Harold T. Davis. Pp. 566. Price $ 2.00.

Within recent years, interest in non-linear equations has grown enormously. They are extremely important as basic equations in many areas of mathematics and physics, and they

have received renewed attention because of progress in their solution by machines. This volume undertakes a definition of the field, indicating advances that have been made up through 1960.

Applied Group-Theoretic and Matrix Methods. By Bryan Higman. Pp. 544. Price $ 2.50.

In part one, the author presents an easily followed discussion of the elementary theory of finite groups, covering such abstract finite groups as cyclical, dihedral, permutation, and S-groups. This is followed by accounts of matrix algebra, complex and hypercomplex numbers, and conjugation and equivalence. In this part there is also a chapter on group representations. In part two, applications of finite groups are treated. A discussion of internal and external crystal structure precedes a chapter devoted to the subject of the vibrations of molecules. The problems of factor analysis are also touched upon.

Introduction to Applied Mathematics. By Francis D. Murnaghan. Pp. 383. Price $ 2.00.

The author covers in detail vector and matrix analysis, partial differential equations, integral equations, calculus of variations, Laplace transform theory, linear vector functions, quadratic bilinear forms, Fourier series, orthogonal curvilinear co-ordinates in the plane and in space, Laplace's equation, problems in electrostatisatics, the method of separation of variables, the methods of inversion, spherical harmonics, Bessel functions, boundary-value problems, self-adjoint linear differential operators, Green's function as a linear integral operator, boundary-value problems of partial differential equations, the Fredholm determinant, the solution of integral equations, Rayleigh's principle, the action integral, the convolution process, the Heaviside expansion formula, and other important topics.

C. V. R.

Books Received

Simultaneous Rapid Combustion Microchemical Research Papers of Mirra Osipovna Korshun. Edited by J. A. Kuck. (Gordon & Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. xv + 560. Price $ 27.50.

Tacheometric Tables (Fourth Edition). By F. A. Redmond. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1964. Pp. xx + 256. Price Rs. 15·00.

The Physical World, An O Level Course (Vol. I) —*Mechanics.* By H. J. P. Keighley and F. R. McKim. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. xv + 223. Price 15 sh.

Biomedical Sciences—Instrumentation (Vol. II). Edited by W. E. Murry and P. F. Sallisbury. (Plenum Press, 227 W, 17th Street, New York, N.Y. 10011), 1964. Pp. viii + 295. Price $ 12.50.

Algæ and Man. Edited by D. F. Jackson. (Plenum Press, New York, N.Y.), 1964. Pp. x + 434. Price $ 14.50.

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SCIENCE NOTES AND NEWS

Award of Research Degree

Andhra University has awarded the D.Sc Degree in Geophysics to Sri. B. Padmanabha Murty and Sri. C. Radhakrishna Murty for their theses entitled "Some Aspects of Moisture Balance in Micrometeorology" and "Remanent Magnetism of the Igneous Rocks in the Gondwana Formation of India" respectively.

Device for Detection of Polar Vapours in Gas Chromatography

A new device to detect polar vapours, installed in gas chromatographic systems, enables discrimination between compounds by differences in polarity. The difference is measured by regarding the change in contact potential caused by the physical adsorption and desorption of polar vapour on a nickel surface. The device has been used to investigate a variety of alcohols, ketones and nitro compounds.

The experimental detector cell consists of two circular plates. One is a $0 \cdot 0005$ inch disc of nickel foil that functions as the sensor plate and the other is a $0 \cdot 002$ inch disc of gold foil called the vibrating plate. The plates are separated from each other by a $0 \cdot 01$ inch mica spacer in such a way that vapour can be passed between them. The signal from the two plates goes to an oscilloscope. When polar vapours are adsorbed on the surface of a solid, they exchange the surface potential. This causes the contact potential of the solid to shift with respect to a less sensitive reference surface. The shift can be measured by a capacitor equipped into dissimilar plates. To cause a polar vapour to adsorb and then desorb on the nickel plate, the nickel is alternately heated and cooled. Heating is accomplished by a 6 V battery, and cooling by precooled nitrogen flowing behind the plate. n-Butanol, acetone and nitromethane have been studied and the sensitivity of the detector has been found to be 10^{15} molecules/c.c., flow rate 200 c.c./min. and response time c. 3 sec.—[*Chem. Engng. News,* 1964. 42, (23) 59.]

Blue Pigment of a Surface-Living Oceanic Copepod

P. J. Herring has reported from R.R.S. *Discovery* now cruising the Indian Ocean, some interesting preliminary observations regarding the blue pigment of plankton organisms living in ocean surfaces. Special nets have made possible collection of surface planktons in the top 4 in. of the ocean water. One of the most striking features of the living hauls is the predominance of blue pigmented organisms, and these have been seen in a wide diversity of groups, among them copepods, mysids, decapods, stomatopod larvæ, siphonophores, chætognaths, salps, diliolids and appendicularians. The most typical members of the catch are pontellid copepods, and these show a blue colour more intense than most other groups. Since blue is a colour almost completely absent in deeper living planktons it was considered to be of interest to make a closer examination of this typical feature of the tropical surface plankton. Using the surface net it was possible to capture very large numbers of *Pontella fera* Dana and carry out a simple analysis of its pigment extracted by grinding the animals, centrifuging the homogenate and filtering the supernatant liquid.

The blue pigment is insoluble in ether, benzene and carbon tetrachloride. Spectrophotometer curve between 400 and 1000 mμ showed a broad absorption band with a peak at about 640 mμ.

It seems probable that the pigment is a chromoprotein complex of a carotenoid and a protein. This is suggested by its initial insolubility in fat solvents, the ease by which it is denatured, particularly when pH changes occur, and the fact that peak absorption after denaturation (presumed to involve breakage of the carotenoid-protein link) is at 450–475 mμ, a region characterstic of the carotenoid pigments commonly found in planktonic animals.

The pigment appears to be uniformly distributed over the body of the animals, but there are concentration sites at the antennæ and over the ventral eye. The reason for the preponderance of blue in tropical plankton is not clear. It may be a camouflage against the predator, or a protection against the strong solar radiation to which the surface plankton is exposed in the tropics.—(*Nature,* 1965, 205, 103.)

A Fifth Natural Force ?

An experiment recently reported by scientists of the Brookhaven National Laboratory has called into question the concept of time-reversal invariance which has been held as a fundamental postulate in nuclear particle reactions. The experiment showed that the neutral K_2

meson occasionally decays into two pi mesons instead of the three pi mesons required if the "CP" rule is to be obeyed. The rule states that particle reactions are indistinguishable from their antimatter mirror images. ("C" stands for charge conjugation, which relates matter to antimatter, "P" stands for parity, which relates a system to its mirror image). On the basis of existing theory the two-pi decay and the CP rule can be reconciled only by sacrificing time-reversal invariance.

Rather than sacrifice time-reversal invariance attempts are being made to find alternative explanations. One such is that the "forbidden" two-pi decay is the first tangible manifestation of a new (fifth) natural force that is even weaker than gravity. The four well-established forces, in order of decreasing strength, are the nuclear force, the electromagnetic force, the weak force (associated with the decay of certain particles) and gravitation. According to time-reversal invariance the four forces are indifferent to the direction in which time is flowing. The proposed force would have one sign (representing a basic characteristic) if produced by ordinary matter and an opposite sign if produced by antimatter.

The new idea can be tested by raising the energy of the decaying K_o particles. If the fifth force is well behaved, the number of two-pi decays should increase by a factor of 100 if the energy of the decaying particles is raised by a factor of 10. Experiments to make this test are now being undertaken in Brookhaven and CERN.—(*Sci. Amer.*, December, 1964.)

Lead Iodide Photography

Thin evaporated layers of lead iodide undergo localised photodecomposition under strong illumination at temperatures near 180° C. This discovery by M. R. Tubbs and A. J. Forty of Bristol University has led to the development of the lead iodide photographic process. In an article contributed to the *British Journal of Applied Physics* (December, 1964) the authors describe the techniques of preparing suitable evaporated films of lead iodide and their use in a wide range of applications.

Thin evaporated films of lead iodide can be prepared in vacuum on a variety of substrates, including glass, fused silica, plastics and metals. A film of $0·15\,\mu m$ is convenient for many applications. The films are sensitive to all visible wavelength below about 520 mμ.

Image recording is carried out by heating the film to 180° C. and illuminating it with the requisite light pattern. A commercial 150 W xenon lamp can provide the necessary high intensity of illumination.

The basic process involves only one operation —that of photodecomposition in which iodide ions are raised to an excited energy level by visible light and then react at a free surface to form molecular iodine and metallic lead. There is no further developing or fixing of the image. The dependence on both high intensities of illumination and high temperature for the occurrence of detectable amount of decomposition permits the films to be prepared and handled with complete safety in daylight at room temperature.

Applications described in the paper (with illustrations) range from simple optical image recording to electron micrography, electron beam writing and the recording of cathode-ray oscilloscope displays.—(*Brit. J. App. Phys.*, 1964. 15, 1553.)

A New Foliage Protectant Fungicide, Tetrachloroisophthalonitrile

Tetrachloroisophthalonitrile (TCPN) is a white crystalline solid melting at ∼ 250° C., virtually insoluble in water (< 0·6 p.p.m.) and only moderately soluble in most organic solvents. Samples stored over one year in the laboratory showed no loss in activity. Aqueous suspensions stored three weeks in the laboratory also showed no loss in activity. It has been shown to be effective as a foliage protectant fungicide. In laboratory and field tests it was equally or more effective than maneb [ethylenebis (dithrocarbomato) manganese], captan [N-(trichloromethythio)-4-cyclohexene-1, 2-dicarboximide], or Botran (2, 6-dichloro-4-nitroanilinic), in controlling early and late blight diseases of tomato, grey leaf-spot on tomato, anthrecnose on tomato, bean rust, and black spot on roses. It was also highly effective in controlling apple scab although not so effective as dodine.

In field trials performed over a wide geographical area in the United States tetrachloroisophthalonitrile was effective in controlling 28 disease organisms on 19 different host plants.

In addition to the broad spectrum of activity and good crop tolerance, TCPN has excellent residual activity and resistance to rain as well as a very low mammalian toxicity.—(*Contrib. Boyce Thompson Inst.*, 1964, 22, 303.)

THE NEW PHYSIOLOGY OF VISION
Chapter XII. Chromatic Sensations at High Luminosities

Sir C. V. RAMAN

THE chromatic sensations excited by light and the closely related topic of the progression of luminosity and colour in a well-dispersed spectrum play a highly important role in the physiology of vision. It emerged from the studies described in the preceding chapters that the sensations of luminosity and colour are so closely interrelated that they have of necessity to be considered together. At the lowest levels of illumination, they are both extremely feeble. They both gain strength as the flux of light reaching the retinæ of our eyes increases. These features naturally also manifest themselves when the light from a source of continuous radiation is dispersed into a spectrum and this is viewed by an observer. There is also a notable difference in the extent of the spectrum exhibited at the levels of illumination which we have referred to as dim light and as bright light respectively. These differences are attributable to the visual pigments which are present in the retina and function at the two levels being altogether different in their spectroscopic behaviours.

It is obviously of importance to carry the studies forward to levels of illumination higher than those which are normally made use of in vision. The results of such study may well be expected to throw fresh light on the nature of the visual processes. This indeed proves to be the case. The observations presently to be described lend impressive support to the findings set out in the two preceding chapters regarding the nature and functioning of the visual pigments.

Technique of Study.—A simple and yet highly effective method has been adopted by the author for investigations in the field outlined above. It consists in the use of a linear source of light and the observation of its first-order diffraction spectrum through a replica grating held by the observer before his eye. The grating employed had 6,000 rulings per centimetre and its first-order spectrum exhibits a dispersion and resolution more than adequate for the purpose in view. A convenient source of light is a tubular lamp along the axis of which is stretched a closely coiled tungsten filament twenty centimetres in length. The current carried by the filament can be varied with the aid of a rheostat so that the radiation emitted by it can be stepped up from a dull red glow to a brilliant white light.

The spectrum is viewed by the observer who places himself at a suitable distance from the light source. This can be varied from the largest distance permitted by the dimensions of the laboratory down to quite small values. The brightness of the spectrum imaged on the retina is thereby enhanced roughly in inverse proportion to the distance. Even when the observer is ten metres away from the light source, the length of the glowing filament enables the width of the spectrum to be sufficient for its characters to be clearly perceived. The increase in luminosity which results from stepping up the heating current is very large for all parts of the spectrum. In particular, the blue-violet sector of the spectrum which is not observable when the tungsten wire emits a feeble red glow gains enormously in intensity when the temperature is raised and a brilliant white light is emitted. But, nevertheless, it continues to be the least luminous part of the spectrum. By the observer moving nearer to the source as also by raising the temperature of the filament, the observed luminosity of the spectrum can be raised from a barely perceptible value to one of considerable brilliance.

Still higher levels of brightness can be attained by using the special type of tungsten filament lamp which is commercially available and is employed for cinematographic projections. In these lamps, the source of light is a coiled-coil of fine tungsten wire placed inside a glass bulb which has a flattened shape. The rear part of the bulb is silvered externally and it acts as a reflecting mirror and brings the emitted light to a focus just outside the bulb. A slit cut in a metal plate and held at the focus allows the light to emerge and functions as a linear source of great intensity. The first-order diffraction spectrum of the illuminated slit can be viewed by the observer from any desired distance.

The Results of the Study.—In the two preceding chapters, the parts of the spectrum between 7,000 and 5,000 angstroms and between 5,000 and 4,000 angstroms in wavelength were separately dealt with and discussed. This bifurcation of the spectrum was justified by the fact that the visual pigments functioning in the two cases are altogether different. It need not therefore surprise us to find that the effect of high luminosities on the visual sensations experienced are of a totally different nature in

the two cases. Accordingly in the present chapter, we shall consider only the spectral region between 5,000 and 7,000 angstroms. The part of the spectrum between 4,000 and 5,000 angstroms will be discussed in the chapter immediately following. As already stated, the techniques of observation enable us to cover a great range of luminosities in the spectrum, from the weakest observable to the strongest attainable. It is convenient therefore to describe the observed effects stage by stage in the same order.

First Stage.—With the tubular lamp emitting a dim red glow and the observer far away from it, the spectrum is at its weakest. The blue-violet sector is entirely absent and the red part of the spectrum also lies outside the range of visual perception. What is then actually observed is the region between 500 mμ and 600 mμ. Despite the dimness of the spectrum, the greenish hue of the part that is visible is recognisable. If now the observer comes nearer the lamp, the red of the spectrum reappears and progressively gains in strength.

Second Stage.—The character of the spectrum is now totally different from that observed in the first stage. The red sector of the spectrum appears in full strength, while the green has gained both in colour and in brightness. These colours are fully saturated and are strikingly contrasted. The transition from the red to the green is fairly rapid and can be located in the spectrum with considerable accuracy. But where the two colours come closest to each other, the progressive change in hue from one to the other with the yellow between them can be readily perceived.

Third Stage.—Further conspicuous alterations in the character of the spectrum are observed when we pass from the second to the third stage. The band of yellow which separates the red from the green is now both broader and brighter. With increasing luminosity, the yellow becomes much the brightest part of the spectrum. The green and the red sectors also exhibit an altered appearance. The changes they exhibit are best described as the result of a progressively increasing superposition of the yellow sensation on the green and on the red sensations. Such superposition would result in altering the perceived colour from green to a greenish-yellow and from red to an orange. These changes spread outwards from the yellow part of the spectrum on both sides to a greater and greater extent with increasing luminosity.

Fourth Stage.—At this stage, the yellow strip in the spectrum attains great brilliance and appears as a band which is far brighter than the regions on either side of it. These latter exhibit the features already described for the third stage.

Fifth Stage.—At this stage, the yellow of the spectrum becomes extremely brilliant and also spreads out to include within itself both the green and the orange tracts of the spectrum. It has then the appearance of an intensely luminous band of an yellowish-white colour with strips of blue and of red of relatively low intensity extending outwards from it on the two sides.

It should be mentioned that the third, fourth and fifth stages can all be quickly traversed and their characteristics noted by an observer with the slit and projection lamp described earlier, merely by varying his distance from the slit or alternatively by varying the electric current through the lamp. These observations establish in a very striking fashion that both in normal circumstances and at the higher levels of illumination, the yellow of the spectrum is the dominant visual sensation and transcends all the other parts of the spectrum in its impact on the centres of perception. Likewise, the visual pigment which enables the perception of the yellow region of the spectrum is clearly the most important of them all.

COLLAGEN ANALYSIS FOR ARCHAEOLOGICAL DATING

THE value of archæological bone samples depends in large measure upon the accuracy with which they can be dated. Unfortunately, an age derived from radiocarbon dating of bone calcium carbonate is usually suspect. It is always possible that the original carbonate has been replaced by that of ground-water ; and ground-water carbonate can be of varying date. Radiocarbon dating, therefore, has been primarily carried out on charcoal found near skeletal remains.

Archæologists have long realized that collagen analysis, if it were possible, would provide a more reliable technique. About 25% of total bone material is composed of collagen, a protein which contains about 50% organic carbon. Recently W. Libby *et al.* have found a method for isolating collagen carbon for dating.

Basically, the method consists of treating a sample of the bone in a weak HCl solution. This dissolves the mineral but leaves the collagen behind. The collagen is then dried and exposed to a stream of oxygen. The oxygen combines with the carbon and forms carbon dioxide, which is then chemically purified ; it is on this form that the carbon is dated.—[*The Sciences* (*N.Y. Acad. Sci.*), 1964, 4 (6), 23.]

INTERNATIONAL HYDROLOGICAL DECADE

M. S. KRISHNAN

INTRODUCTION

OUT of the total surface area of the globe (510,101,000 km.²), about 29·2% (148,892,000 km.²) consists of land above sea-level. The land is very unevenly distributed, there being twice as much land in the northern hemisphere as in the southern. Within the northern hemisphere again, the greatest stretch is found between latitudes 15° and 65°. More than half of the land (about 56%) lies below an altitude of 500 m., about half of this being between sea-level and 200 m. It is in these areas that the greatest concentration of the world's population occurs.

The precipitation of water, as snow and rain, on the earth's surface, is also quite irregular. This depends on the configuration and morphology of the land and of the atmospheric circulation. Only a few coastal tracts and certain other restricted areas lying in the path of moisture-laden winds receive more than 40 inches of rain per year. The arid regions are those which get less than 10 inches of rain per year while those which get between 10 and 20 inches are classed as semi-arid. The arid lands form about 25% of the total land area and lie mostly between 15° and 35° latitudes on either side of the equator, though this distribution is not regular. In North Africa, the aridity in certain areas is caused by descending air currents which become compressed and heated and thereby the air abstracts moisture leaving the ground drier than before. In Central Asia, the interior is intensely heated in the summer, but receives so little moisture that it is dry all through the year.

Parts of the Sahara, Central Arabia and Central Asia contain the most forbidding deserts of the world. The deserts occupy some 14% the land surface while the semi-desert steppes occupy another 14%, making up a total of 16 million sq. miles (41 million km.²). The area of the Sahara is 3·5 million sq. miles, most of it stone-covered, with extremely low rainfall. The Australian desert covers nearly 1·3 million sq. miles. The Arabian desert covers 1 million sq. miles, a third of it being sand-covered; its interior is called, quite appropriately, 'the empty quarter'. The Turkestan desert occupies 0·75 million sq. miles, abutting against the Caspian Sea on its west. The Persian desert is 150,000 sq. miles while the Takla Makan in the Centre of Asia covers 200,000 sq. miles,

merging into the semi-arid areas of Mongolia and Kazakhstan. The Atacama desert of Chile-Peru occupies some 140,000 sq. miles of the S. American Pacific Coast, the coastal area being often foggy. The Patagonian desert further south, to the east of the Andes, has an area of 260,000 sq. miles. South-Western U.S.A. is another area of desert and semi-desert covering half a million sq. miles. The Kalahari in South Africa contains some 220,000 sq. miles of desert surrounded by a large semi-desert. It will thus be seen that a very large area of the globe is unsuitable for human activity. Out of the remaining area of land, the ice-covered Arctic and Antarctic regions as well as the mountainous regions are also unsuitable, leaving only the rain-receiving plains and plateux and parts of the mountainous regions for human settlements.

For some years past, the UNESCO has taken great interest in the study of the problems of the arid and semi-arid tracts and an expert Committee, consisting of eminent hydrologists, meteorologists and geologists, has been directing the work of research teams. Arid zone research institutes or units have been functioning in the Sahara, South Africa, Western U.S.A. and other places. One has been set up recently at Jodhpur to study the problems of the Rajasthan region and it is already engaged in questions relating to re-forestation, ground water, fixation of sand-dunes, etc. Water-supply is one of the major problems of the arid and semi-arid regions and has been receiving much attention.

WATER-SUPPLY—A WORLD PROBLEM

Next to air, water is indispensable for living beings. Human settlements have been established from the very earliest times near sources of freshwater such as large rivers and fresh-water lakes. Until recently, when the need for large quantities of water for industrial purposes has necessitated the scientific study of water resources, their development and conservation, there has not been much difficulty in securing the requirements of water from the usual sources of supply. During recent decades, monetary and engineering resources have been utilised for constructing reservoirs to ensure large supplies of water, but this has now to give way to systematic studies of the sources of water-supply. Such investigations require full data on meteorological, geological and hydrological factors in order that the principles

of storage of water, its distribution, its movement, etc., can be properly understood, before the sources can be developed and used to the best advantage. At present, only a few advanced countries have given serious thought to the various problems relating to surface and ground water. The necessity for carrying out similar studies in other countries is now felt in an acute manner ; hence the question of the scientific study of hydrology in all its aspects has become a world problem to be tackled as a well-co-ordinated international project.

The distribution of water resources lends itself to study on a large scale both regionally and at a continental level. Very often, the problems involve more than one nation in any particular region. It becomes then necessary for several nations to come to an agreement about the utilisation of their common resources in an equitable manner. Some rivers and lakes are common to two or three countries and this makes it incumbent on these countries to share their experience and pool their resources for properly developing and utilising the water available in the tract to the best advantage of all.

Need for Collection of Data

Water-supplies are controlled by rainfall, climate, local geography and geology and are liable to vary from time to time. The proper understanding of these factors in their local relationship and interdependence will take a fairly long period. This fact as well as the great magnitude of the problem have suggested that hydrological studies should be undertaken over a period of at least a decade in order that the data collected are reliable. During this period it would be possible to delineate the chief lines of investigations, but these will have to be extended further in future. Such studies will require trained personnel for investigations both in the field and in the laboratory. It is only a few countries which already have the resources for investigation at present. Most other countries will require either finance or trained personnel and facilities, or both. Only when proper organisations are set up in each country and the necessary finance secured for continuous studies, will it be possible to make good progress.

In these investigations the range of data to be collected is quite large and expensive. These will include rainfall and its variations over a long period, the influence of local climatic factors, the amount of surface water available, the distribution of ground water in relation to the local geology and structures, and other

relevant information. This will be followed by a systematic study of hydrological factors and the making of water inventories. Local factors will always have to be given special attention as they may not conform to any general pattern. The development of the resources will require the use of advanced engineering techniques which will be available only in industrially advanced nations. After the water is used it will have to be disposed of in such a way that much of it can be utilised again whenever possible.

In the initial stages many countries which are technically backward will have to apply their resources to the collection of basic data and the training of personnel for undertaking the tasks in a systematic manner. The making of water inventories will have to be in two or more stages, firstly for immediate and pressing needs of the local population and for agricultural uses. Then come the requirements of such industries as can be profitably set up in the region. Other aspects of study can follow later after the personnel gains experience. Thus, all countries will, in the first instance, have to set up training schools and hydrological services which will have to fit into an international pattern ; numerous observation stations must be established for collection of rainfall and other data such as the distribution of surface water, evaporation absorption by the gound, flow in rivers, etc. Later on ground water will have to be examined from the point of view of both the ultimate and actually recoverable resources. Tests will have to be made to determine what part of the ground water can be brought to the surface and utilised without overpumping and otherwise spoiling the reservoirs. Permanent research organisations and laboratories will have to deal with all questions coming under the purview of research development and utilisation. Liaison will have to be established with other countries not only for standardisation of data but also for discussion and solution of common problems.

Hydrological Studies in the U.S.A.

In this connection it would be instructive to examine a few facts relating to advanced countries. It has been calculated that, if the amount of water evaporated from the sea surface can be precipiated entirely over the surface of land uniformly, it will form a layer 100 inches thick. This amount is approximately three times the potential annual evaporation from all the land surface. For continental U.S.A., excluding Alaska, the average annual rainfall is 30″ (including snowfall). The amount of

water precipitated on this area (about 2,000 million acres) is about 5,000 million acre-feet per year. Probably about 10 times this amount is stored as underground water, though unevenly in different areas. About 70% of this water is evaporated or transpired by plants into the air, leaving only 30% to flow on the surface and to sink into the ground. Only 7% of the annual precipitation (about 345 million acre-feet) or about one-fourth of the stream flow is utilised for agriculture, irrigation and all other purposes. Less than half of this is used for agriculture while a similar quantity is used for industrial cooling, washing, etc. Only a comparatively small quantity is used for domestic and municipal purposes. The amount of water actually consumed comes ultimately to 2% of the total precipitation as the rest of the amount withdrawn is returned to the ground and to the streams (Revelle, 1963).

The average daily use of water in the United States is at present said to be about 570 million m.³ for major industries, 510 million m.³ for irrigation and 100 million m.³ for household and other purposes. This gives a total of 1,180 million m.³ which when divided by the population (180 million) gives the *per capita* consumption of 6·6 m.³ per day (Spiegler, 1962). The average daily use of water by individuals and by families varies considerably in different areas because those in the dry areas naturally use less water than those who live in the humid areas.

The consumption of water is steadily increasing not only because of increase in population but also because of the expansion in the variety of human activities and industries.

A Senate Committee on Water Resources in the U.S.A. has estimated that the actual consumption of water (year 1960 ?) was about 110 billion gallons per day and that the existing storage capacity is 278 million acre-feet. According to them, by 1980 the US will consume about 190 billion gallons per day and an *additional* storage capacity of 315 million acre-feet will be required, *i.e.*, more than double the present capacity. (1 acre-foot = 1233·5 m.³ = 325,850 US gallons). It is stated that, in spite of the great progress already made in hydrology in that country, the available information is still inadequate and that a major effort is needed in research for a comprehensive study of ground water. We can therefore envisage the inadequacy of our position.

Treatment of Saline Water

Every country which has embarked upon industrialisation is now finding that the usual sources of water relied upon till now are not sufficient and that extra supply will have to be obtained either from large distances or from the conversion of sea or lake water. The consumption of water for drinking purposes alone is of the order of 2 to 8 litres per day per person according to the season, the environment, the nature of work on which the person is engaged, etc. But drinking water is not the most serious problem. The requirements for other purposes such as for agriculture and industries are much heavier.

Drinking water should not ordinarily contain more than 500 parts of dissolved salts per million parts of water, though some variation may be allowed. It is known that in some parts of Africa the local tribes use water having as much as 2,500 parts of dissolved salts per million without serious effects, but this is a very extreme case. This latter concentration should be considered too high even for several of the food crops.

Certain countries which have had to face acute shortage of water are already turning to the ocean for obtaining their supplies. Sea-water is quite unsuitable for most purposes as it is; but it has been converted into potable water on board ships for some decades. In recent years, particularly after the second world war, the conversion of sea-water into fresh-water has been taken up for careful study. There are at present several industrial plants working on desalination of sea-water, for example in Kuwait, Israel, Libya, South Africa and Virgin Island. Most of these are still working on an experimental basis. A few plants are also experimenting with various methods in the USA, so that the basic data as well as the advantages and disadvantages of each may be evaluated for long-term adoption.

The simplest is the distillation of water by evaporation which may be done through the help of hot steam. Evaporation by the sun's heat has also been tried but it does not seem to be very attractive compared to other methods. Multi-stage evaporation is found to be more economical than single-stage because of the saving of heat. Another method is that of flash distillation in which heated water is allowed to evaporate suddenly when it enters a space where the pressure is low. This produces a flash of steam. This method is used in Kuwait and Virgin Island. Another process employs freezing; water when freezing rejects the dissolved salts and is therefore more or less free

of salts. A more recent process uses electro-dialysis; in this there is a series of cells separated by membranes which are alternately permeable to positive and negative ions when electric current is passed through the unit. In one set of cells the salts become concentrated while in the alternate set depletion of salts takes place; thus the latter cells will produce practically fresh water. Ion exchange resins are also used for purifying saline water. Raw water is passed through a column of active cation exchanger containing resins with hydrogen ion which are exchanged with positive ions in the water. The water which thus becomes acidic then passes through an anion exchange column where another type of resin exchanges all negative ions with OH. Thus the original ions are exchanged with H and OH, finally giving practically fresh water (H_2O). The ion exchange process is perhaps the most costly of all and therefore cannot be used on a large scale, unless there are special reasons for adopting it.

Cost of Desalination of Sea-Water

Regarding the cost of making potable water from salt-water some data have been released in the USA. There are five experimental plants in that country where approximate costs have been worked out. The plant at Freeport (Texas) which uses multi-effect vertical distillation tubes with a capacity of one million gallons per day (m.g.d.) cost 1·25 million dollars to erect. The plant at Webster (S. Dakota) uses electro-dialysis method, and it costs 0·25 million dollars; one at San Diego (California) with a capacity of 1 m.g.d. uses multi-stage flash distillation; its cost was 1·6 million dollars. Another plant at Roswell (New Mexico) uses the vapour compression process; it has a capacity of 1 m.g.d. and cost 1·8 million dollars. The fifth plant at Wrightville (N. Carolina) uses the freezing processes and has a capacity of 1 m.g.d. and it was put up at a cost of 1·25 million dollars. Initially the average cost of the water produced by these plants was around 4 dollars per 1,000 gallons, but it has since been reduced to 1 to 1·5 dollars per 1,000 gallons. The cost was worked out on the basis of a period of 20 years amortisation of capital, and 4% interest. It is expected that when larger plants could be put up, the cost can further be reduced perhaps to 0·5 dollar per 1,000 gallons in the most favourable conditions. On the other hand, the cost of water from ordinary wells and reservoirs is now of the order of 15 to 25 cents per 1,000 gallons in general, but it is gradually going up. Estimates by people experienced in

the processes mentioned above go to show that a plant having a capacity of 30 m.g.d. would be able to produce water at 50 to 60 cents per 1,000 gallons in the near future; this of course depends to some extent on fuel cost which, if obtained cheaply, may bring down the water cost further. In any case, it is not expected that the cost of water can be reduced below 30 cents per 1,000 gallons even under the most favourable conditions. It is also gathered that the combination of a plant to produce both power and water may reduce the cost further. With a power plant of the capacity of 70,000 KW, and fuel available at 10 cents per million BTU, the cost is approximately 5 millions per KWH. If such a plant is combined with one for producing 14 or 15 m.g.d. the cost would be around 27 to 30 cents per 1,000 gallons, making allowance for capital, fuel operation maintenance of other charges. If the capacity is increased to 25 to 30 m.g.d. the cost may be lowered to 25 cents per 1,000 gallons. There are, however, other factors to be taken into consideration in these estimates.

Need for Worldwide Studies

For many years past there has been an International Association of Scientific Hydrology (IASH) which is now a member association of the International Union of Geodesy and Geophysics (IUGG). Several advanced countries have also Societies of Hydrologists who are studying the scientific as well as technical aspects of water utilisation. The idea of studying the water resources on a worldwide scale has been exercising the minds of many specialists. In 1961 the National Academy of Sciences of USA appointed a Committee to go into the question of the study of water resources in a manner similar to some of the geophysical studies undertaken during the International Geophysical Year (IGY). This led, in October 1961, to a discussion of the broader aspects of hydrology at a meeting of the IASH in Athens. The Executive Committee of this Association approved of the idea of taking up hydrological studies on a worldwide scale and circulated the information to the National Committees of some 45 countries who were members of the International Council of Scientific Union (ICSU) for their comments. By the middle of 1962 some 27 countries responded, most of them being enthusiastic in their support to an international programme. In the meanwhile the proposal was brought to the notice of the UNESCO whose support had to be secured as the programme had to be given official status. The Executive Board of the UNESCO at its Session in

November 1961 recommended to the Director-General to make provision for an International Conference to explore the ways of undertaking a programme of research and training in hydrology. It also proposed a meeting to be held in collaboration with the international organisations affiliated to the United Nations such as WMO, FAO, WHO, etc. The WMO fully supported the programme at its meeting held in May 1962 and promised active participation. The Advisory Committee on Arid Zones, of the UNESCO, also supported the proposition at its meeting in August 1962. In May 1963, the UNESCO arranged for an International Meeting for considering the whole programme and the various problems connected with it. A working document was prepared and distributed to all the Member-States of the UNESCO. The meeting was attended by 48 countries in addition to representatives of the International and Scientific Organisations. The result of these discussions was circulated by the UNESCO which invited each country to indicate what action it proposed to take, with such modifications as were considered necessary. The UNESCO agreed to provide a central secretariat for the international programme which was proposed to be called the "International Hydrological Decade" as it was thought that a period of at least 10 years would be required for gathering worthwhile data and achieving some useful results. The UNESCO document of June 1964 gave reality to the programme which was initiated by the U.S. Academy of Sciences and by the IASH. It was decided to set up a council for the International Hydrological Decade to enable a detailed programme of planning and research to be drawn up by the various National Committees and other Organisations. It was also agreed that the IASH, which is a body of hydrologists, would be the consultants and advisers for the scientific aspects of the programme, particularly for establishing training institutions for the personnel that would be required to carry out the programme. By the middle of 1964 several countries have already begun to organise and plan for the collection of data and training of personnel.

THE PROGRAMME

The lines of investigation to be undertaken during the International Hydrological Decade will be quite comprehensive and will consist of the following :

Organization.—The setting up of hydrological units and training of technical personnel in hydrology and engineering aspects ; liaison between technical and administrative sections ; liaison between different countries through the UNESCO ; arrangement of programmes and documentation of results and distribution of informations to all countries.

Field-Work.—Measurement of precipitation, percolation, evaporation and run off ; chemical studies on the nature of water ; preparation of maps and charts.

Surface Water Flow.—Water and sediment in river flow ; erosion ; transport and sedimentation ; occurrence of floods and the local causes ; soil moisture and loss of water ; study of the best methods of using water for agriculture.

Ground Water.—Geological, geophysical and geochemical studies of wells and boreholes ; fluctuation of ground water level ; discharge and recharge of aquifers ; coastal water and its relation to sea-water ; salinity ; drainage, irrigation and water-logging.

Influence of Man.—Destruction of forests, effects of roads and railways, water pollution, etc.

Engineering Aspects.—Construction of dams, canals, irrigation works and industrial plants ; improved methods of planning and development of water resources and their utilisation, and waste disposal.

Legal.—Uniform water laws in all countries as far as possible.

Conservation.—Best methods of using water for various purposes ; purification of used water ; return of water and recharge of aquifers ; standardisation of quality.

These various problems will now be systematised for study and implementation by the different countries so that the water resources in the various regions can be utilised in a scientific and systematic manner. Though the project is planned for a decade, it will only be the beginning of the scientific study and rational use of the water resources by the whole world.

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BIOCHEMICAL CHANGES IN MOUSE BLOOD AND LIVER FOLLOWING
STAPHYLOCOCCUS AUREUS INFECTION

K. L. MUKHERJEE, I. M. SMITH AND S. S. LINDELL,

Infectious Disease Division, Department of Medicine, University of Iowa, Iowa City,
Iowa 52241, U.S.A.

STAPHYLOCOCCUS AUREUS causes many serious and minor infections including septicemia, pneumonia, boils, carbuncles, impetigo and others. Careful diagnosis and systematic treatment are necessary to avoid complications.[1] Recently it has been suggested that "chemotherapy", or perhaps better "chemical therapy", in combination with "antibiotic treatment" might have promise. Additionally, to avoid empirical (instead of rational) use of antibiotics, a thorough knowledge of the altered metabolism of infection is necessary.

In view of our past experiences[2-4] we have designed an experimental model in mice where we inject *Staphylococcus aureus*, Smith (obtained from a patient with osteomyelitis and maintained in the laboratory) by *in vitro* passage.[3] A heavy dose of 1×10^9 cells is injected by the intraperitoneal route into white Swiss male mice weighing approximately 22 gm. This infection produces death in 254 minutes ($\pm 27 \cdot 7$ minutes). In the present paper, autopsies were done at the 'time of death' (in a group of ten mice, when the second animal died the remaining eight were decapitated and used for analysis).

The behaviour of the animal after injection is quite consistent. Piloerection around the neck occurs within 60 minutes. Mice begin grouping together after 90 minutes, presumably due to body cooling. Their temperature falls 20 to 30° F. Unsteady walking begins after 120 minutes followed by dyspnea in about 150 minutes. A fall of the respiratory rate (240/min. to 140/min.) is obvious and respiration later becomes labored and irregular. After 150 minutes the mice begin erratic jumping at irregular intervals and thrash their tails. Death ensues at an average of 254 minutes after infection with a generalized clonic convulsion and incontinuance of urine.

Of the various biochemical analyses done so far, including inorganic salts, sugars, phosphates and nitrogen fractions, a significant variation from the normal (Table I) mice is seen only in case of those analyses which are shown in Table II.

A fall of glucose demonstrates the effect of staphylococcus on carbohydrate metabolism. Subcutaneous injection of glucose within an

TABLE 1

*Normal values of blood and liver of mice for the biochemical analyses which have shown significant changes**

	Whole blood	Liver	References to methods followed
Glucose	52·7	125·0	5
Cholesterol	139·0	33·0	5
Alkaline phosphatase (s.u.)	4·1	37·4	6
Inorganic phosphate	3·8	35·0	7
Organic phosphate	42·2	132·3	7
Acid-soluble organic phosphate	N.D.	32·2	7
Inorganic P/Organic P (ratio)	0·09	0·26	7
Non-protein nitrogen	13·0	220·0	5
Urea nitrogen	8·3	180·0	5
Amino acid nitrogen	4·0	35·0	8,9

* Unless otherwise stated, blood values are in mgm./100 ml. and liver values are in mgm./100 mgm. fresh weight.
N.D. = Not done.

TABLE II

Significant biochemical changes in blood and liver of staphylococcus (S. aureus) infected mice

(All values expressed as per cent. normal)

	At death from infection	
	Whole blood	Liver
Glucose	67†	12†
Cholesterol	7†	94
Alkaline phosphatase	138†	118*
Inorganic phosphate	132†	140†
Organic phosphate	84†	93
Acid-soluble organic phosphate	N.D.	53†
Inorganic phosphate/organic phosphate	164†	172†
Non-protein nitrogen	122*	265†
Urea nitrogen	122*	300†
Amino-acid nitrogen	125*	115*

* Significant at 10% level.   † Significant at 5% level.
N.D. = Not done.

hour before or after staphylococcal injection increased the survival time 27%. Changes in cholesterol suggest that fat breakdown follows infection. A rise of inorganic phosphate with a concomitant fall of organic phosphate cause a striking rise of inorganic phosphate/organic phosphate (Pi/Po) ratio. This strongly suggests the rapid breakdown of organic phosphate following bacterial infection. The significant

fall of the acid-soluble organic phosphates suggests that energy-rich phosphates and other easily available organic phosphates are disappearing. A high degree of protein breakdown is also clearly demonstrated from the nitrogen analyses. Infection causes the degradation of protein and thus increases the amino nitrogen values which in turn leads by degradation to increased urea formation.

The results are preliminary in nature. The details of the altered biochemical pathways in infected animals are still in the realm of conjecture. The biochemical data reported here could be directly or indirectly related to staphylococcal infection or may even be effects of any death process. The multiple effects of the bacterial toxins make the approach all the more complicated. *In vitro* attempts with mouse liver and staphylococci to attempt to clarify the events have been discouraging. Isolation and identification of the lethal factor will help us approach the problem more systematically. Recently we have been able to extract the lethal factor from the staphylococcus after subjecting the bacteria to high pressure (40,000 psi).[10] Further purification is necessary before it is identified. Until then, more biochemical data need to be gathered from *in vivo* studies. In our experimental model the presence of live bacteria or live cytoplasm is necessary for the fatal effect on the mice. Culture filtrates, penicillin or heat-killed bacteria do not carry the lethal factor. Injection of infected homogenized liver killed normal mice in about the same time (254 minutes) only when the lethal concentration of 1×10^9 bacterial cells/ml. was present in the homogenate. Treatments with hexoses, pentoses, cortisone, phosphate buffer and 1/6 M sodium lactate or 10% oxygen at 6/10 atmospheres are found to be effective in increasing the survival time.[11-14] Cortisone or oxygen treatment can lead to 40–95% prolongation in the length of life of infected mice. Work is still under progress to establish the pathway of staphylococcal effect on carbohydrate, phosphate and nitrogen metabolism.

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GEOLOGY OF MARION ISLAND

MARION Island lies in latitude 46° 49′–46° 59′ S., longitude 37° 35′–37° 55′ E. It measures 12 miles east-west, by 7 miles north-south, and rises to a maximum height of 3890 ft. The island is wholly volcanic. A younger and an older lava series are present, with intercalated agglomerate and numerous large scoria mounds. Most of the island is built up of the older lavas, chiefly dark-coloured olivine basalts varying in their degree of compaction and often carrying phenocrysts of olivine. There are several light-coloured flows with a distinctive platy habit. The platy lavas have a relatively even grain and contain less basic plagioclase. They **are** trachytes.

The most distinctive feature of Marion Island from off-shore is the very numerous reddish scoria mounds dotted all over the Island. They rise up to 700 ft. above their surroundings. Their conical shape is frequently perfectly preserved, and some retain crater-shaped depressions at their summits.

The age of the older lavas is uncertain. Behind the shifted coast-line the lower slopes of the Island locally exhibit a mature land surface. By analogy with other oceanic islands, they may date back as far as the Tertiary. The later lavas and scoria mounds are clearly of very recent age.—(*Nature*, 1965, 205, 64.)

LETTERS TO THE EDITOR

MEAN AMPLITUDES OF VIBRATION : PYRAMIDAL XYZ₂ TYPE MOLECULES

THE pyramidal XYZ_2 type molecules have the symmetry C_s and give rise according to selection rules $4a' + 2a''$ type vibrations, all active in Raman and infrared spectra. The symmetry co-ordinates and the elements of the kinetic energy matrices used in the present investigation are the same as given by Venkateswarlu and Rajalakshmi.[1] In the present work, an attempt has been made to study the mean amplitudes of vibration for NH_2D, NHD_2, NF_2H and NF_2D molecules at 298° K. using Cyvin's[2] secular equation method. While computing the mean amplitude elements proper account has been taken of the appropriate equilibrium bond lengths of the molecule.

The harmonic wave-numbers for NH_2D, NHD_2, NF_2H and NF_2D have been calculated using the observed fundamentals and the anharmonic constants. The anharmonic constants x_{ii} and x_{ii} are obtained for the a' and a'' species using the method suggested by Dennison.[3] The harmonic wave-numbers and the anharmonic constants are given in Table I, along with the observed fundamentals.

The molecular parameters used in the calculations are given in Table II.

TABLE II

Molecular parameters of pyramidal XYZ_2 type molecules

Molecule	R (Å)	r (Å)	α	β	Ref.
NH₂D ⎱ NHD₂ ⎰	1·014	1·014	110°	110°	4
NF₂H ⎱ NF₂D ⎰	1·026	1·400	99·8°	102·9°	5

Using the principle suggested by Cyvin,[2] the secular equations giving the normal frequencies

in terms of the mean-square amplitude quantities σ at 298° K. were constructed with the help of Σ and G^{-1} matrix elements. The mean amplitudes of vibration for both the bonded and non-bonded atom pairs for the molecules are listed in Table III.

TABLE III

Mean amplitudes of vibration for pyramidal XYZ_2 type molecules (Å)

Atom pair	NH₂D	NHD₂	NF₂H	NF₂D
X—Y ..	0·0848²	0·07295	0·07379	0·06460
X—Z ..	0·07224	0·06469	0·04797	0·04787
Z...Z ..	0·13480	0·11060	0·06656	0·06573
Y...Z ..	0·12900	0·13020	0·12190	0·11090

The following conclusions may be drawn from the results presented in Table III.

1. The mean amplitude of vibration is the same for the N—H atom pair in NH_2D, NHD_2 and NF_2H.

2. The mean amplitude of vibration for the N—D bond is also the same for the molecules NH_2D, NHD_2 and NF_2D.

3. The N—F mean amplitude quantity is found to be the same in NF_2H and NF_2D.

4. The F...F non-bonded mean amplitude value is almost the same in NF_2H and NF_2D.

TABLE I

Harmonic wave-numbers (cm.⁻¹) and anharmonic constants

Type of vibration	Observed				Calculated				Anharmonic constants			
	NH₂D	NHD₂	NF₂H	NF₂D	NH₂D	NHD₂	NF₂H	NF₂D	NH₂D $x_{ii}{}^{*}$	NHD₂ x_{ii}	NF₂H x_{ii}	NF₂D x_{ii}'
a'	3307⁴	3378⁴	3193⁵	2333⁵	3465	3495	30 8	2235	..	..	..	..
	2444	2389	1307	1008	2561	2173	1231	965	0·0434	..	0·0227	..
	1609	1255	972	972	1686	1299	916	931	..	0·0349	..	0·0106
a''	994	905	500	500	1042	937	471	479	..	..	..	..
	3378	2500	1424	1042	3330	2506	1456	1059	0·0039	0·0029	−0·0580	−0·0424
	1393	1476	888	888	1398	1480	908	903	..	..	..	..

These mean amplitude values may be useful in electron diffraction measurements of these molecules.

Dept. of Physics,   K. VENKATESWARLU.
Kerala University,   (MISS) V. MALATHY DEVI.
C/o U.C. College, Alwaye,
South India, *December 4, 1964.*

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COMPLEXES OF CUPRIC ION

STUDIES on formation and properties of complexes between cupric ions and various ligands like halide ions, anions from various acids, etc., in aqueous solution especially by spectrophotometry are limited. Mc Connel and Davidson[1] and Kruh[2] have reported different values for the formation constant, K for the complex $CuCl^+$. The former have also reported under conditions of very high chloride concentration formation of an ion pair $CuCl_4^=$ which has absorption peak in the visible ($\lambda = 380$ mμ–440 mμ). We have investigated by spectrophotometry complexes between cupric ions and chloride ions, anions from various acids—(formic ; acetic ; propionic ; lactic ; β-hydroxy propionic ; itaconic, etc.), as ligands with a view to determine the formation constants and associated thermodynamic functions and to investigate the photosensitizing properties of these complexes.

Cupric perchlorate in aqueous solution has been used as the source of cupric ions. Analar acids have been used as sources for ligands. All absorbancy measurements have been made in a Hilger U.V. spectrophotometer under conditions of constant ionic strength, pH range, temperature, etc. A typical study is briefly described : Optical density *vs.* Wavelength curves are constructed for 1 : 1, 1 : 2, 1 : 3, 1 : 4 mixtures (by molarity) of cupric ion and ligand acid respectively to determine the wavelength region for absorption and to get a rough idea of number of complexes formed from the shape of these curves. Composition of each complex is determined by Job's method[3] extended by Vosburgh and Cooper.[4] The data are treated to Mole ratio method[5] also to check the composition and stability of the complex. Effect of pH on the stability of each complex is also studied. From measurements of optical densities of a series of dilutions of the composition of the complex and from a knowledge of extinctions for cupric ion and the complex, the dissociation constant of the ligand acid and pH, the formation constant for the complex has been evaluated.
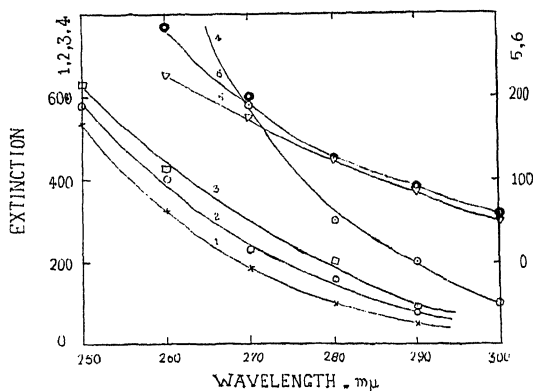
We report briefly the following results :—

(*i*) Our values for $CuCl^+$ at 25° C., and $\mu = 1$, K = 0·297 litre/mole and $\triangle H = 4834$ calories, $\triangle S = 15·979$ calories per degree. The divergence between our value for K and those by Mc Connel and Davidson (1·296 litre per mole) and Kruh (0·27 litre per mole) is attributed to the fact that small differences in the optical density values reflect large differences in the K values. We find that there is no initiation of vinyl polymerisation on irradiation of the system $CuCl_4^=$-Vinyl monomer, (with $\lambda = 365$ mμ–546 mμ) which indicates that the dark back reaction in $CuCl_4^= \xrightarrow[kd]{h\nu} CuCl_3^= + Cl$ is quite fast. (*ii*) (*a*) Optical density vs. λ curves for 1 : 1, 1 : 2, 1 : 3, 1 : 4 mixtures of cupric ion and ligand acid indicate that the effective wavelength region is between 250–350 mμ for $\lambda > 3500 < 6000$ Å there is negligible absorption. With each ligand the curves for various mixtures have similar shape and therefore formation of one type of complex only is concluded in each case. Job's method of continuous variation extended by Vosburgh and Cooper, has given a maximum of 0·5 mole fraction and therefore formation of 1 : 1 complex in each case is concluded. (*iii*) Application of Mole ratio method does not give a sharp break at 1 : 1 mole ratio for any acid. Beyond 1 : 1 ratio the optical density continues to increase. Degree of dissociation of the complex[6] $a = (\Sigma_m - E_x)/E_m$ for each complex has however been evaluated and the values are : 0·89 (formate ligand) ; 0·94 (propionate) ; 0·90 (isobutyrate) ; 0·92 (lactate) ; 0·84 (itaconate) ; 0·84 (β-hydroxypropionate). E_m, the maximum extinction for the 1 : 1 complex has been evaluated from optical density for a solution in which

FIG. 1. Curve (1) Copper formate ; (2) Copper propionate ; (3) Copper iso-butyrate ; (4) Copper lactate ; (5) Copper itaconate ; (6) Copper β-hydroxy propionate,

(Acid)/(Cu^{++}) $\simeq$ 400 and E_s is the extinction at the stoichiometric molar ratio of the complex. (iv) The extinction *vs.* λ for various 1 : 1 complexes are given in Fig. 1. (v) Log of formation constants (log K) for various 1 : 1 complexes are : 2·0 (ligand formate, 28° C., $\mu = 0.5$); 2·3 (propionate, 30° C., $\mu = 0.1$); 2·55 (lactate, 31·5° C., $\mu = 0.1$); 2·05 (β-hydroxy propionate, 30° C., $\mu = 0.1$), 2·44 (isobutyrate, 30° C., $\mu = 0.1$); 5·00 (itaconate, 30° C., $\mu = 0.1$).

A detailed paper with experimental results and discussion will appear elsewhere.

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University of Madras,   M. SANTAPPA.
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HOPPER GROWTH IN BISMUTH

AMELINCKX[1] has suggested a dislocation mechanism for the growth of hopper crystal faces and has observed them on salol and thymol. Hurle[2] has observed facets on decanting bismuth which are the {100} planes, frequently with a diagonal twin plane. Wagner and Brown[3] have observed {111} facet planes also and have explained the morphology of the twinned crystals. We have been studying the effect of various parameters such as growth rate, temperature gradient and impurity concentration on the growth of bismuth single crystals and we thought of studying the facets of crystals obtained by decanting also. Bismuth of 99·9% purity was heated and brought to the molten state. This molten mass was allowed to cool for ninety seconds and then the contents of the crucible were suddenly decanted. Hopper type crystal faces were observed on the substrate sticking to the crucible. Figure 1 shows a hopper crystal face obtained in this way. This hopper crystal face is the {100} face and must have developed due to the large supercooling by the sudden decantation of the metal from the crucible and segregation of impurities at these points.

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FIG. 1

guidance in the work and to the M.S. University for the award of a Government of India Research Training Scholarship.

Physics Department,   B. S. SHAH.
M.S. University of Baroda,
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TRIPHENYL PHOSPHINE, CARBONYL, BROMO COMPLEXES OF RHODIUM

COMPOUNDS of the type L$_2$ Rh(CO)Cl (L is a ligand of the type Ph$_3$P or Ph$_3$As) have been prepared by boiling rhodium trichloride with excess of the tertiary phosphine or arsine in high boiling alcoholic solvents like methoxy and ethoxy ethanol.[1,2] Employing this elegant method two bromo complexes have been prepared for the first time using methoxy ethanol as the solvent.

Crystals of hydrated rhodium bromide were prepared by dissolving freshly precipitated rhodium hydroxide in warm hydrobromic acid (1 : 1) and evaporating the solution under vacuum. 0·75 gram of RhBr$_3$ x H$_2$O was added to 130 ml. of methoxy ethanol containing 4 ml. of water and 4·5 grams of triphenyl phosphine. The contents were refluxed for two hours when yellow crystals appeared to separate. On cooling the solution to room temperature 1·2 gram of the crystals were isolated from the mother liquor. The compound was analysed by standard methods for both bromine[3] and phosphorus.[4] On the basis of analytical results the formula [(C$_6$H$_5$)$_3$ P]$_2$ Rh(CO)Br could be assigned to the compound [C$_{37}$H$_{30}$OBrP$_2$Rh requires Br = 10·86, P = 8·43; found, Br = 10·43, P = 8·34%],

The infra-red spectrum of the compound taken in nujol shows a carbonyl peak at 1980 cm. [1] The crystals were found to be soluble in chloroform and nitrobenzene but were insoluble in water and alcohol. The substance is a non-electrolyte in nitrobenzene.

The tribromo compound $[(C_6H_5)_3P]_2Rh(CO)Br_3$ was prepared by treating the monobromo complex (0·24 gram) with the calculated quantity of bromine in chloroform at 0° C. The orange crystals (0·27 gram) could be isolated after evaporation under vacuum. Analysis of bromine and phosphorus gave a value of 26·41 and 6·73% respectively. Calculated values for the same in the tribromo complex require 26·78 and 6·92% respectively. The compound was soluble in chloroform and nitrobenzene and was a non-electrolyte in the latter.

The tribromo complex shows a carbonyl peak in the infra-red at 2110 cm.[-1] The occurrence of C=O stretch in the infra-red at 1980 cm.[-1] for the Rh(I) compound as compared to 2110 cm.[-1] for the Rh(III) compound is similar to the observation made in the case of the corresponding chloro compounds.[5] This suggests that the metal carbon bond in the Rh(I) complex is stronger than the one in the Rh(III) complex.

It is of interest to mention that earlier attempts to prepare such bromo complexes starting from $L_2Rh(CO)Cl$ were not successful.[6]

The authors are indebted to Dr. M. Shadaksharaswamy for his keen interest in the work and to Dr. A. R. V. Murthy for useful discussions. The infra-red spectra were taken at the Department of Organic Chemistry, Indian Institute of Science, Bangalore.

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THE ELECTRON SPIN RESONANCE SPECTRUM OF GAMMA IRRADIATED SODIUM TETRATHIONATE

The authors have reported on the e.s.r. spectra of gamma irradiated thiosulphates.[1] It was found to be of interest to record the electron resonance spectrum of sodium tetrathionate during a study of the effect of Co⁶⁰-gamma radiation on alkali tetrathionates.[2]

Sodium tetrathionate dihydrate, $Na_2S_4O_6.2H_2O$, was prepared by mixing c.p. grade sodium thiosulphate and iodine by the method given in Abegg's *Handbuch der Anorganschen Chemie*.[3] The salt was purified by repeated precipitation from aqueous solution with 95% ethanol. The purity and composition of the final sample was carefully checked by (*i*) obtaining its infra-red spectrum,[4] (*ii*) analyzing for tetrathionate content by the method of Goehring *et al.*,[5] (*iii*) dehydration and (*iv*) conversion to sodium sulphate on heating to 600° C.

The irradiation source employed was a commercial unit "Gamma Cell 220 Co⁶⁰ Irradiation Unit" manufactured by the Atomic Energy of Canada Ltd. The exposure dose was around 10^5 roentgens per hour. A Fricke dosimeter was used for measuring the dose absorbed by the samples.

A Varian Associates V-4500 E.P.R. Spectrometer was used for obtaining the e.s.r. spectrum of the irradiated samples. The unit is an X-band spectrometer with a nominal operating frequency of 9500 Mc./S. The experimental details are given elsewhere.[1] Electron spin concentrations were measured by graphical double integrations of the recorded spectra and comparison, through a substandard of gamma irradiated barium dichloroacetate, with solutions of D.P.P.H. in benzene.

The e.s.r. spectrum for the irradiated salt is shown in Fig. 1. The vertical line indicates the
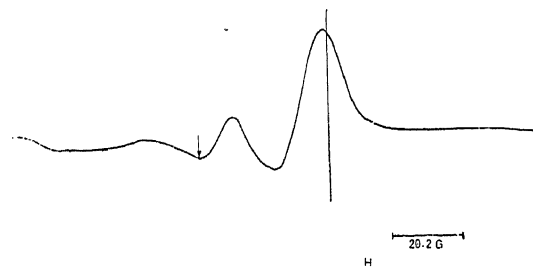
FIG. 1. Electron spin resonance spectrum of gamma-irradiated $Na_2S_4O_6.2H_2O$ at room temperature. The vertical line indicates the position of the D.P.P.H. spectrum. The vertical arrow is at a *g* value of 2·024.

position of the D.P.P.H. spectrum. The magnetic field increases from left to right. The spectrum consists of a single absorption line with a low field structure and measures about 90 gauss. No hyperfine splitting was observed. The *g* value for the main cross-over point is 2·009. The

line width Δ_{MS} (the width between the points of maximum slope taken from the first derivative of the e.s.r. spectrum) is $13 \cdot 1$ gauss. The electron spin concentrations were found to increase at first with an increase in absorbed dose but became almost constant at higher doses. The maximum value observed was $6 \cdot 8 \times 10^{17}$ spins per gram of the irradiated salt for an absorbed dose of $5 \cdot 7 \times 10^{20}$ ev per gram.

The above results alone are not sufficient to make a positive identification of the radical (or radicals) responsible for the e.s.r. spectrum. By their observations on liquid sulphur and other sulphur compounds, Gardner and Fraenkel[6] have made the tentative suggestion that polyatomic free radicals in which the odd electron is primarily associated with a sulphur atom would be expected to have a g value of about $2 \cdot 02$. However, if the odd electron is in a sulphur containing compound and is not primarily localized on a sulphur atom, the g value would be closer to the free spin value of $2 \cdot 0023$. The g value of $2 \cdot 009$ obtained for sodium tetrathionate has a considerable g shift from the free spin value. This could indicate that the unpaired electron is considerably involved with a sulphur atom in the free radical responsible for the spectrum. Further, the value is significantly higher than the g values reported for sodium dithionate[7] and sodium dithionite,[8] which could mean that the central line in the spectrum may not be due to SO_3 or SO_2^- radical ions.

The g factor calculated for the low field shoulder of the low field structure is $2 \cdot 024$. Spectroscopic splitting factors about 1% larger than the free electron spin g factor of $2 \cdot 0023$ have been reported in the e.s.r. spectra of sulphur dissolved in oleum[9] and of chilled sulphur vapour.[10] This is ascribed to spin orbit interactions and hence free radicals in which the odd electron is primarily involved with the sulphur atom could be responsible for this structure. Such a conclusion is supported by the observation that colloidal sulphur is produced when gamma irradiated tetrathionate is dissolved in water.[2]

Dept. of Chemistry and   D. S. MAHADEVAPPA.*
    Chemical Engineering,   R. L. EAGER.
University of Saskatchewan,
Saskatoon, Sask., Canada,
December 28, 1964.

* Present Address: Department of Chemistry, Post-graduate and Research Section, University of Mysore, Mysore, India.

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STUDIES ON THE USE OF 8-HYDROXY QUINOLINE AND SOME OF ITS DERIVATIVES AS REDOX INDICATORS

IT has been observed that 8-hydroxy-quinoline and its derivatives, oxine-5-sulphonic acid and 7-iodo-oxine-5-sulphonic acid (ferron) undergo oxidation on adding cerium (IV) sulphate, to an almost colourless state through intermediate unstable red brown and red products respectively. If iron (II) is added to the solution of these oxidized substances while still the brown or red product is present, it is reduced back to the original oxine or its corresponding derivative, whereas if they are oxidized beyond the red stage, they cannot be reduced at all by adding iron (II). Thus the oxidation-reduction is reversible only up to the red stage. In this communication, the results of the studies on the use of these substances as redox indicators, based on the reversible nature of their oxidation, are recorded.

EXPERIMENTAL

Indicator Solutions.—$0 \cdot 005$ M solutions of the oxine, oxine-5-sulphonic acid and ferron are prepared respectively by dissolving (1) $0 \cdot 0725$ gm. of oxine in 100 ml. $0 \cdot 1$ N sulphuric acid, (2) $0 \cdot 1126$ gm. of oxine-5-sulphonic acid in 100 ml. of warm distilled water and (3) $0 \cdot 1756$ gm. of ferron in 100 ml. of distilled water. $0 \cdot 5$ ml. of any of these indicator solutions is found adequate in titrations.

Cerium (IV) sulphate solution is prepared from a sample of (G.R, E. Merck) ceric ammonium sulphate by dissolving it in sulphuric acid and the solution is made up to the desired

volume, keeping the overall acidity 1 N with respect to sulphuric acid. This solution is standardised by potentiometric titration with standard oxalate solution.[1]

Iron (II) solution is prepared by dissolving the requisite amount of (G.R, E. Merck) ferrous ammonium sulphate in 1 N sulphuric acid solution and is standardized by titration with the above ceric sulphate, using ferroin as indicator.

All other chemicals used are of reagent grade quality.

Of the three substances, we find that ferron and oxine-5-sulphonic acid are preferable in view of their water solubility and easily discernible colour change at the end-point to oxine which is soluble in acids only.

In titration of iron (II) sulphate in sulphuric acid medium with cerium (IV) sulphate, these indicators give sharp end-points. The acidity can be varied from 0·5 to 6 N without any effect on the end-point. In hydrochloric acid medium, the intense yellow colour of ferric chloride complex masks the colour change at the end-point, but this difficulty can be overcome by adding about 5 ml. of syrupy phosphoric acid to the titration mixture. In perchloric and nitric acid media, using cerium (IV) perchlorate or cerium (IV) nitrate for the titration of iron (II) perchlorate, up to 2% higher titres are obtained because of simultaneous oxidation of the indicator to the irreversible stage. It is obvious from these observations that sulphate ion has some retarding effect on the irreversible oxidation of these substances. With permanganate as oxidant, the oxidation of the indicators to the irreversible stage occurs so rapidly that the red product is hardly perceived. Dichromate and vanadate require 15 and 20 N acidity respectively to oxidise the indicators. However, in actual titrations of iron (II) sulphate, the detection of the colour change of the indicators at the end-point is made difficult by the green chromium (III) and the blue vanadium (IV) that are generated in the titration mixture. Thus, these substances are not suitable as indicators in permanganometry, dichrometry and vanadametry.

Transition Potential of the Indicators.—By adopting the procedure of Belcher, Nutten and Stephen,[2] we found that the colour change of these indicators occurs at 950 ± 10 (mV) *vs.* N.H.E. in the titration of iron (II) sulphate with cerium (IV) sulphate in 1 N sulphuric acid medium. The potential at which the colour changes in the reverse titrations could not be

determined due to the fact that it is irreversibly oxidised in presence of excess oxidant.

Indicator Correction.—The indicator correction is determined by noting the difference in the titres obtained potentiometrically and with the indicator using 0·5 ml. of 0·005 M solution. It is observed that if a titration is carried out potentiomtrically with the indicator present in the mixture, the break is obtained only after all the indicator is oxidised. The correction thus determined amounts to 0·22 ml. of 0·01 N cerium (IV) sulphate.

Recommended Procedure for the Determination of Iron (II).—An aliquot of iron (II) sulphate is taken in a conical flask and acidified with sulphuric acid such that the overall acidity is 1 N on dilution to 50 ml. 0·5 ml. of 0·005 M solution of either of the indicators is added and the solution is titrated with cerium (IV) sulphate with vigorous stirring till the colour changes to red.

Some typical results of such titrations are given in Table I.

TABLE I

Amount of iron (II) taken millimoles	Amount of iron (II) found millimoles
0·2354	0·2364
0·3356	0·3366
0·5359	0·5359
0·5509	0·5509
0·7161	0·7176
0·9716	0·9726
1·118	1·119
1·275	1·277

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OCCURRENCE OF MANGANESE ORES IN ADILABAD DISTRICT, ANDHRA PRADESH

KING (1881), Heron (1948) and Pascoe (after Hughes, 1948) who worked on geology of parts of Adilabad District, Andhra Pradesh, have not made any reference to the manganese ores now under report. Geological Survey of India

announced about the occurrence of manganese ores in this part in December 1962.

Economically workable deposits of manganese ores are found in Jamdapur (Long. 19° 44'; Lat. 78° 31'), Ghotkur (Long. 19° 44'; Lat. 78° 30') and Pippargunta (Long. 19° 45'; Lat. 78° 29'). One of the authors (G. S.) mapped the ore deposit and the associated rock types on 4" = 1 mile scale in 1963, and made a representative collection of ore and associated rock types for further mineralogical and petrographic work.

The manganese ores are bedded and are conformable with the associated limestones and are considered to be Penganga in age. The bedded nature and similar structural deformation in the ore, as also in the associated limestones, suggest it to be sedimentary and syngenetic.

The essential ore minerals are braunite. hausmannite, pyrolusite and psilomelane. A part of the ore body is altered and in such parts, it is associated with irregular jasper bands. Most of the ore minerals are idiomorphic to subidiomorphic; the granularity is variable from fine to coarse. The microstructures exhibit banding (colloform, concretion and replacement).

The limestones associating ore vary in colour from buff to gray and are succeeded by shales on the top. They are overlying in order sandstones, a discontinuous thin conglomeratic horizon, and granite, which forms the basement. The granite sandstone contact is disconformable. So the sequence from top to bottom in the area can be given as follows: shales, limestones (manganese ore), sandstones—unconformity—(conglomerate) and granite.

The position of the manganese ores in this sequence suggests them to be Pengangas, the exact stratigraphic position of which is controversial. Lithologically the Penganga beds are said to have much in common with the Kurnool series of Andhra. These were correlated with the limestone group (upper stage) in the sequence of Chattishgarh basin. King (1881) considered the Penganga beds to be Pakhals. Heron (1948) correlated them with Pakhals of the Godavary Valley.

The correlation of the manganese ores of Adilabad District with those in other parts of India (Eastern Ghats, Sausar series) is not possible and the manganese deposits in these places were formed at different periods during Pre-Cambrian, perhaps due to one and the same process, namely sedimentation.

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Andhra University,   G. SRINIVASACHARY.
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ON THE OCCURRENCE OF *GLOBOTRUNCANA* IN ARIYALUR STAGE OF TRICHINOPOLY CRETACEOUS, SOUTH INDIA

THE note embodies the results of micropalæontological investigations carried out on the material, collected from the basal part of the Ariyalur stage, Cretaceous of Trichinopoly, South India. The rocks of the Ariyalur formation have yielded prolific foraminiferal fauna, the earliest record of which was made by Stoliczka.[1] Later, Narayana Rao[2] and Rama Rao[3,4] made exhaustive foraminiferal studies from the Orbitoid-bearing Arenaceous Limestone referred to Ariyalurs and better known as "Gryphœa bed" representing Mæstrichtian horizon, occurring east of the town of Ariyalur. Recently, the present authors[5-7] have also carried out detailed investigations on the foraminiferal assemblage of the Orbitoidal Limestone east of Ariyalur, and reported the occurrence of *Globotruncana arca* (Cushman) and *Globotruncana gansseri* Bolli, in association with *Orbitocyclina ariyalurensis* Rao, *Lepidorbitoides inornata* Rao, *Lepidorbitoides blandfordi* Rao, and *Siderolites calcitrapoides* Lamarck, typical of the Mæstrichtian age.

Sastry, Mamgain and Rao[8] have recorded the occurrence of *Globotruncana lapparenti tricarinata* (Quereau) and *Globotruncana* cf. *lapparenti lapparenti* Brotzen from the basal Ariyalurs outcropping near the village Sadaiyakkanpatti about 4 miles north of Ariyalur. They assigned a Campanian age to this bed on account of the presence of the above species of *Globotruncana*, absence of *Orbitoidal* fauna and stratigraphically lower position from that of the Mæstrichtian Orbitoid-bearing bed.

The present paper deals with the foraminiferal content from a marl bed obtained from a wellcutting east of the village Sillakkudi (97° 1': 11° 4' 45") on way to Kannanore. The material was collected during the month of March 1964.

This study is significant, since the present locality hitherto considered unfossiliferous from the foraminiferal point of view, has now yielded a rich assemblage of foraminifera which throws important light on the age of the enclosing beds. The rocks occur few feet below the surface, inter bedded with cream-coloured gritty sandstone and consist of buff-coloured, soft and highly friable, marly shale somewhat gypseous. This marly bed has yielded abundant *Globotruncana* species in association with other foraminifers, but is conspicuously devoid of typical Mæstrichtian *Orbitoidal* and *Siderolites* fauna. The foraminiferal fauna yielded by this bed is listed below:

Textularia sp., *Robulus* sp., *Lenticulina* sp., *Marginulina* sp., *Nodosaria* sp., *Dentalina* sp., *Lagena* sp., *Nonion* sp., *Nonionella* sp., *Discorbis* sp., *Gyroidina* sp., *Anomalina* sp., *Globotruncana* sp., *Globotruncana lapparenti lapparenti* Brotzen, *Globotruncana lapparenti tricarinata* (Quereau).

The Sillakkudi bed is characterised on the one hand by the occurrence of *Globotruncana lapparenti tricarinata* (Quereau) and *Globotruncana lapparenti lapparenti* Brotzen in abundance, and on the other hand by the conspicuous absence of the typical foraminiferal species of Mæstrichtian age like *Lepidorbitoides inornata* Rao, *Lepidorbitoides blandfordi* Rao, *Orbitocyclina ariyalurensis* Rao and *Siderolites calcitrapoides* Lamarck. Moreover, this bed occupies stratigraphically lower position than that of the Orbitoid-bearing bed. In view of the above facts, a Campanian age has been assigned to this bed, which suggests that it may be synchronous with the *Globotruncana-lapparenti-tricarinata* bed reported from Sadaiyakkanpatti by Sastry, Mamgain and Rao.

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OCCURRENCE OF TWO *VAGINICOLID* SPECIES (PERITRICHA: CILIOPHORA) FROM CHITTOOR, ANDHRA PRADESH

Of the 90 species of Vaginicolidæ (Noland, 1959) known to science, 5 species are reported from the Indian sub-continent (Bhatia, 1936 ; Naidu, 1965). They are *Vaginicola* sp., *Thuricola obconica* Kent, *Pyxicola carteri* (Kent), *Cothurina annulata* Stokes and *Cothurina* sp. The last mentioned undetermined species of *Cothurina* is *Cothurina imberbis* Ehrenberg.

This note reports the occurrence of two vaginicolid ciliates, *Pachytrocha cothurnoides* Kent and *Cothurina imberbis* Ehrenberg. Both are new to this sub-continent. They were collected by the author from filamentous algæ of an old unused well at Chittoor, Andhra Pradesh.

Pachytrocha cothurnoides Kent (Fig. 1)
Noland, 1959, p. 294, Fig. 10.32(g).

Dimensions : Lorica : $77 \mu \times 30 \mu$,   aperture : 20μ wide, neck : 16μ wide.
     Extended animal : $100–110 \mu$. long.
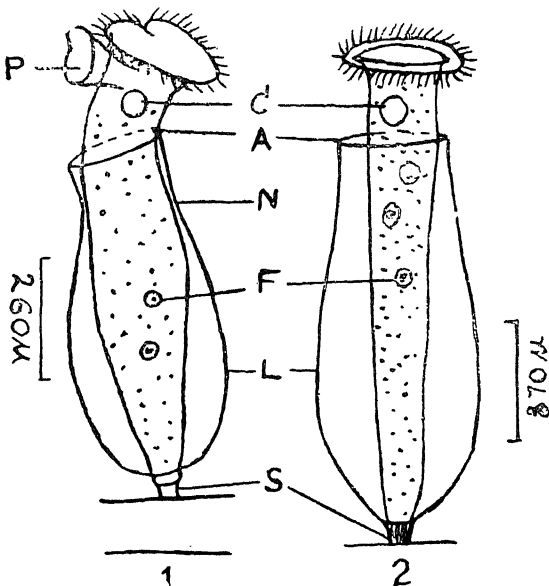
FIGS. 1–2.   Fig. 1. *Pachytrocha cothurnoides* Kent. Fig. 2. *Cothurina imberbis* Ehrenberg.   A, aperture ; C, contractile vacuole ;   F, food vacuole ;   L, lorica ; N, neck ; P, protoplasmic plug ; S, stalk.

The lorica (Fig. 1) is flask-shaped, brown, with a neck less wide than the aperture. It is attached at right angles to algal filaments by a short stalk. When the animal is retracted into the lorica, a circular protoplasmic plug fits into the neck and in extension this plug is pushed to one side of the peristome. Macronucleus is band-shaped. Contractile vacuole single.

Cothurina imberbis Ehrenberg (Fig. 2)
Noland, 1959, p. 294, Fig. 10.32(c).
Cothurina sp., Naidu, 1965, (in press)
Dimensions : Lorica : 54 μ × 26 μ, neck : 17 μ, aperture : 18 μ.
Extended animal : 70–75 μ.

The lorica (Fig. 2) is flask-shaped, colourless with a broad neck ending in an aperture. It is attached at right angles to algal filaments by a short stalk. Macronucleus is band-shaped. Contractile vacuole single.

Remarks : This was already recorded from a tank at Nandalur, Cuddapah District, Andhra Pradesh as *Cothurina* sp. (Naidu, 1965).

Department of Zoology,   K. Vanamala Naidu.
Government Arts and
  Science College,
Chittoor (A.P.), *September* 5, 1964.

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STIMULATING EFFECT OF SOME CELLULAR COMPONENTS OF *ALTERNARIA* SP. UPON THE GROWTH OF A *NOSTOC* STRAIN

The present communication summarises the preliminary observations on the effect of the mycelial extracts of a species of *Alternaria*, isolated from the surface of the legume nodules[3] on the growth of a *Nostoc* strain.

The mycelial mat of the fungus was removed from the culture medium by filtration, repeatedly washed and pressed in between a blotter. 250 mg. of the fungal mat were extracted with 10 ml. of (*i*) EtOH at 75° C. for 1½ hr., (*ii*) N/20 HCl at 37° C. for 24 hr. and (*iii*) water at room temperature for 36 hr. The acid extract was neutralised with N KOH. 10 ml. portions of Fogg medium[2] fortified with nitrate (0·25 g. KNO₃/1.) were placed in quintriplicate series of sterile test-tubes to which

1 ml. of the fungal extract was added in an undiluted form and also in 1 : 10 and 1 : 100 dilutions. Each tube was seeded with 1 ml. of a uniform suspension of an endophytic strain of *Nostoc*, ARM 59.[1] All the cultures were maintained under identical conditions of temperature and continuous illumination.

The growth criterion used for the alga was the optical density of the methanol extract of the alga at 660 mμ as measured in a DU Beckmann Spectrophotometer, since chlorophyll *a* showed a conspicuous peak at this wavelength (Fig. 1).

FIG. 1. Absorption spectrum of the methanol extract of *Nostoc* strain.

FIG. 2. Absorption spectrum of the methanol extract of *Nostoc* strain grown in presence of the mycelial extracts of *Alternaria* sp. I, acid extract ; II, alcoholic extract ; III, aqueous extract. A, undiluted ; B, C, 1 : 10 and 1 : 100 dilutions respectively ; D, control.

From Fig. 2, it is seen that in terms of optical density at 660 mμ, the final yield of the alga at the end of 12 days was significantly increased in all the series to which undiluted fungal extracts were added, indicating the presence of some substance(s) in the fungal mat which accelerates remarkably the growth of *Nostoc*. With the acid extract, the optical density was about five times more than the control and about twice as that with the alcoholic and aqueous extracts. The effective substance(s) seems to be thermolabile and more readily soluble in aqueous acid than in alcohol or water. The culture filtrate of this fungus has, however, been shown to inhibit the growth of rhizobia.[3]

The present investigation indicates that this fungus contains some substance(s) which is readily metabolised by the alga. Further work on the interaction between various algæ and fungi will show whether there exists a beneficial microbiocœnosis among these organisms in the soil. With the instances of lichens, such a possibility cannot, however, be ruled out.

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Algæ Section,   S. K. GOYAL.
Division of Microbiology, G. S. VENKATARAMAN.
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A NATURALLY OCCURRING DICENTRIC CHROMOSOME IN *ELEUSINE CORACANA* (LINN.) GAERT.

CHROMOSOMES with two centromeres are known as dicentric chromosomes. They commonly occur after breakage and reunion in chromosomes following irradiation or a treatment with some radioactive substance. Darlington and Wylie[1] classified the known dicentrics as induced or spontaneous with three categories of behaviour : temporary, permanent, and persistent. The dicentric chromosomes described here in *Eleusine coracana* are spontaneous and temporary.

Eleusine coracana, the Finger Millet, is widely cultivated for fodder and human consumption in India, Africa and parts of Asia, especially in Malaya and China. Seeds were obtained from

Patna (India) and Uganda, Samaru (Nigeria). Local seeds were three to four years old. Young root tips of seedlings and young anthers were used for chromosome studies. The Feulgen squash technique was used for staining the chromosomes.

In root-tips $2n = 36$ chromosomes was observed in the seeds grown from Uganda. In the local material, the chromosome number varied from 30 to 36 per cell in one and the same root-tip (Fig. 1 ; *see* Table I). This observation was made on several root-tips. About 15·6% of anaphase plates showed 1 to 3 chromosome fragments and 32·5% of anaphases showed "Bridges", single, double (Fig. 2) or

FIGS. 1–2. Fig. 1. Mitotic metaphase from root-tip showing 32 chromosomes, × 1,150. Fig. 2. Two dicentric chromosomes are seen at anaphase as bridges, × 2,166.

triple, sometimes with fragments. The percentages of the higher numbers of chromosomes increase with the age of the seedlings, ending in the recovery of a normal chromosome number $2n = 36$. Secondary and tertiary root-tips when examined were found to have a normal set of 36 chromosomes. The meiotic division appears normal, with 18 bivalents at diakinesis and metaphase I. Sometimes some bivalents were seen lagging at anaphase I, but their separation was ultimately complete.

It appears from Table I that the percentages of even numbers of chromosomes are higher

TABLE I

Variation in chromosome number in four root-tips, fixed 4, 5, 8 and 9 days after sowing

Chromosome Number	Percentage of cells			
	4 days	5 days	8 days	9 days
30	23·4	19·0	18·6	14·7
31	4·4	4·07	2·3	0·0
32	30·3	24·2	23·2	14·4
33	6·2	5·7	5·1	4·4
34	28·1	33·5	36·3	44·1
35	1·4	1·1	0·8	0·0
36	7·0	12·1	13·9	22·1

than the odd numbers. Presumably both atypical numbers are the result of the formation of

The lorica (Fig. 1) is flask-shaped, brown, with a neck less wide than the aperture. It is attached at right angles to algal filaments by a short stalk. When the animal is retracted into the lorica, a circular protoplasmic plug fits into the neck and in extension this plug is pushed to one side of the peristome. Macronucleus is band-shaped. Contractile vacuole single.

Cothurina imberbis EHRENBERG (FIG. 2)
Noland, 1959, p. 294, Fig. 10.32(c).
Cothurina sp., Naidu, 1965, (in press)
Dimensions : Lorica : 54 μ × 26 μ, neck : 17 μ,
aperture : 18 μ.
Extended animal : 70–75 μ.

The lorica (Fig. 2) is flask-shaped, colourless with a broad neck ending in an aperture. It is attached at right angles to algal filaments by a short stalk. Macronucleus is band-shaped. Contractile vacuole single.

Remarks : This was already recorded from a tank at Nandalur, Cuddapah District, Andhra Pradesh as *Cothurina* sp. (Naidu, 1965).

Department of Zoology,　K. VANAMALA NAIDU.
Government Arts and
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STIMULATING EFFECT OF SOME CELLULAR COMPONENTS OF *ALTERNARIA* SP. UPON THE GROWTH OF A *NOSTOC* STRAIN

THE present communication summarises the preliminary observations on the effect of the mycelial extracts of a species of *Alternaria,* isolated from the surface of the legume nodules[3] on the growth of a *Nostoc* strain.

The mycelial mat of the fungus was removed from the culture medium by filtration, repeatedly washed and pressed in between a blotter. 250 mg. of the fungal mat were extracted with 10 ml. of (*i*) EtOH at 75° C. for 1½ hr., (*ii*) N/20 HCl at 37° C. for 24 hr. and (*iii*) water at room temperature for 36 hr. The acid extract was neutralised with N KOH. 10 ml. portions of Fogg medium[2] fortified with nitrate (0·25 g. KNO$_3$/1.) were placed in quintriplicate series of sterile test-tubes to which

1 ml. of the fungal extract was added in an undiluted form and also in 1 : 10 and 1 : 100 dilutions. Each tube was seeded with 1 ml. of a uniform suspension of an endophytic strain of *Nostoc.* ARM 59.[1] All the cultures were maintained under identical conditions of temperature and continuous illumination.

The growth criterion used for the alga was the optical density of the methanol extract of the alga at 660 mμ as measured in a DU Beckmann Spectrophotometer, since chlorophyll *a* showed a conspicuous peak at this wavelength (Fig. 1).

FIG. 1. Absorption spectrum of the methanol extract of *Nostoc* strain.

FIG. 2. Absorption spectrum of the methanol extract of *Nostoc* strain grown in presence of the mycelial extracts of *Alternaria* sp. I, acid extract ; II, alcoholic extract; III, aqueous extract. A, undiluted ; B, C, 1 : 10 and 1 : 100 dilutions respectively ; D, control.

From Fig. 2, it is seen that in terms of optical density at 660 mμ, the final yield of the alga at the end of 12 days was significantly increased in all the series to which undiluted fungal extracts were added, indicating the presence of some substance(s) in the fungal mat which accelerates remarkably the growth of *Nostoc*. With the acid extract, the optical density was about five times more than the control and about twice as that with the alcoholic and aqueous extracts. The effective substance(s) seems to be thermolabile and more readily soluble in aqueous acid than in alcohol or water. The culture filtrate of this fungus has, however, been shown to inhibit the growth of rhizobia.[3]

The present investigation indicates that this fungus contains some substance(s) which is readily metabolised by the alga. Further work on the interaction between various algæ and fungi will show whether there exists a beneficial microbiocœnosis among these organisms in the soil. With the instances of lichens, such a possibility cannot, however, be ruled out.

The helpful discussions of Drs. W. V. B. Sundara Rao and N. S. Subba Rao are gratefully acknowledged. We are also thankful to Dr. B. P. Pal, Director, for his interest and encouragement.

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Division of Microbiology, G. S. VENKATARAMAN.
Indian Agric. Res. Inst.,
New Delhi-12, *September* 25, 1964.

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35	1·4	1·1	0·8	0·0
36	7·0	12·1	13·9	22·1

than the odd numbers. Presumably both atypical numbers are the result of the formation of

bridges, leading to subsequent loss either of fragments or whole chromosomes and cells which have lost only one chromosome are less viable than those which lost two. Possibly two chromosomes are more often lost together than one only ; or at times a fragment might be counted as one chromosome in metaphase plate.

The diminution in chromosome number in mitotic metaphase is due to the loss of dicentric chromosomes as bridges at anaphase and the cells with less number of chromosomes (minus bridges) take part in further division which also eventually get behind in competition with cells with more number of chromosomes or normal set of chromosomes. The percentage of odd number of chromosomes at metaphase is quite consistent with the percentage of fragments found at anaphase plate.

The occurrence of dicentric chromosomes has also been described in various other species by different authors.[1-7] Regarding the origin of the spontaneous dicentric chromosomes different scientists have suggested different theories. In the present material the dicentric may presumably originate by high temperature and longer period of storage of seeds at which the chromosomes break and rejoin with each other or between its chromatids. However, the abnormalities are conditioned by the treatment of the seeds between collection and sowing.

My thanks are due to Mr. W. H. Foster, Regional Research Station, Samaru, Nigeria, for supply of seed, and to Prof. R. P. Roy and Dr. A. S. Yadav for their encouragement.

Botany Department,   D. N. Singh.
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CERCOSPORA PLUCHEA-TOMENTOSAE SP. NOV. ON *PLUCHEA TOMENTOSA* DC. IN INDIA

Severe leaf-spotting of *Pluchea tomentosa* DC. has been observed at the Allen forest in January 1964 and later at Kalyanpur in Kanpur District in August, 1964. The disease starts on the leaf as minute brownish spots which are also found on the stem in the advanced stage of the disease. The leaf spots are amphigenous, circular to irregular, 1–5 mm. in diameter, pale pinbish buff on the upper surface and olive brown on the lower surface. Sporulation is amphigenous but it is more on the lower surface than on the upper surface of the leaves.

Morphology of the fungus.—Stroma globular to somewhat irregular, dark brown in colour, 10·8 to 25·9 μ diam. ; conidiophores in fascicles of 3–11 or more, 2–6 septate, 2–5 geniculate, tip sub-truncate, straight to mildly curved, Prout's brown to mars brown in colour with cinnamon buff contents, 53·9–129·5 × 4·3–6·4 μ in size, mostly emerging through epidermal cells ; conidia hyaline, acicular, base obconically truncate, tip round to sub-acute, 2–7 septate, straight to slightly curved, not constricted at the septum, 12·9–86·3 × 2·1–4·3 μ in size (Fig. 1).
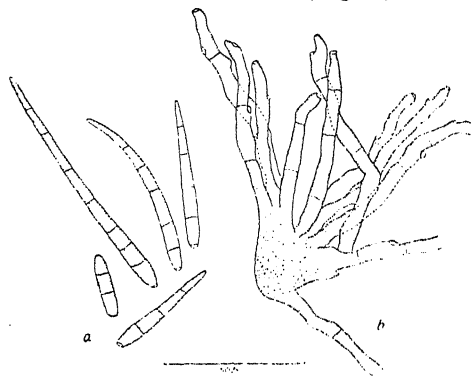
Fig. 1. *Cercospora pluchea tomentosæ.* (*a*) Conidia. (*b*) Stroma with conidiophores.

Petrak and Ciferri (1930)[1] reported *Cercospora plucheæ* Petrak and Ciferri on *Pluchea odorata* (Compositæ) from San Domingo, Bermuda, Mona and Venezuela which differs from this fungus in having smaller conidiophores (40–110 × 3–5·5 μ) and larger conidia (30–120 × 4–5·5 μ). Mr. F. C. Deighton of the Commonwealth Mycological Institute, Kew, Surrey, England, is of the opinion that the fungus causing the leaf-spots of *Pluchea tomentosa* at Kanpur is a new species of *Cercospora* similar in general characters with *Cercospora apii*. Hence the name *Cercospora pluchea-tomentosæ* is proposed for which the Latin diagnosis is given blow :

Cercospora pluchea-tomentosæ Sp. Nov.

Maculæ amphigenæ, e circularibus irregulares, 1–5 mm. diam. ; pallide roseæ in facie superiore, marginibus 'mars' brunneis, olivaceobrunneæ in facie inferiore, sporulatione amphigena sef copiosiore in facie superiore ; stroma globosum vel aliquantum irregulare, fusce brunneum, 10·8 to 25·9 μ diam. ; conidiophora fasciculata 3–11 vel plura, 2–6 septata, 2–5 geniculata, apice

subtruncato, recta vel paulum curvata, brunneo colore 'Prout's' vel 'mars', contentis cinnamomobubalinis, $53\cdot9-129\cdot5 \times 4\cdot3-6\cdot4\,\mu$ vulgo emergentia per cellulas epidermales ; conidia hyalina, acicularia, obconice truncata ad basin, rotunda vel subacuta ad apicem, 2–7 septata, recta vel paulum curvata, non-constricta ad septa, $12\cdot9-86\cdot3 \times 2\cdot1-4\cdot3\,\mu$.

In foliis viventibus *Plucheæ tomentosæ* DC. a familia Compositarum, ad Kanpur in India mense januario 1964 ; R. C. Tripathi. Typus positus in IMI ad Hortum Kewensem sub numero 106286.

Thanks are due to Mr. F. C. Deighton for his help in identifying this fungus and to Dr. H. Santapau for its Latin diagnosis.

Section of the Plant   R. C. TRIPATHI.
  Pathologist to Govt.,   R. S. MATHUR.
Kanpur (U.P.), *Sept.* 17, 1964.

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STIPULAR SCLEREIDS IN *RHIZOPHORA MUCRONATA* L.

SCLEREIDS are reported to be present in stem, root, leaf, fruit and seed.[1] Their occurrence in the stipules is uncommon. In course of our anatomical studies on mangroves, sclereids in the stipules of *R. mucronata* were observed. Mullan[2] reported that in the leaf, H-shaped and stellate spicules are "mostly confined to a short distance on either side of the mid-rib" and only H-shaped ones are present in the other part of the leaf-blade, in relation with the minor veins, both on the upper and lower sides of each vascular bundle. Rao[3] tentatively classified these foliar sclereids as diffuse type. Mullan[2] and Rao[3] did not report the stipular sclereids in *R. mucronata*.

The stipules are 2–3 inches long, interpetiolar, glabrous and caducous. They strongly ensheath the young leaves. The stipule is thickest in the middle region and gradually thins out towards its edge (Fig. 1). The outer and inner tangential and radial walls of the abaxial epidermis are strongly thickened. The stomata are observed in the abaxial epidermis but are not sunken as reported in the leaf.[2] The ground tissue cells are generally thickened and not differentiated into palisade and spongy parenchyma. Next to the adaxial epidermis and 1–3 rows of elongated cells of the ground tissue, a number of vascular strands is observed (Fig. 2). Sclereids are abundant, polymorphic and diffuse. They are either in aggregate forming distinct strands or occasionally solitary (Figs. 1, 2). The strands

are usually above the vascular bundles (Figs. 1, 2). Mainly two types of sclereid forms are distinguished, though intergrading forms are common. They are spheroidal ones which are strongly pitted (Figs. 3, 7) and the astrosclereids which are highly branched and sparingly pitted (Figs. 4–6). The arms of such sclereids are usually elongated in the direction of the longer axis of the stipule (Fig. 2). Some yellowish or brownish contents are occasionally present in spheroidal sclereids. H-shaped and filiform forms are also present (Fig. 8).
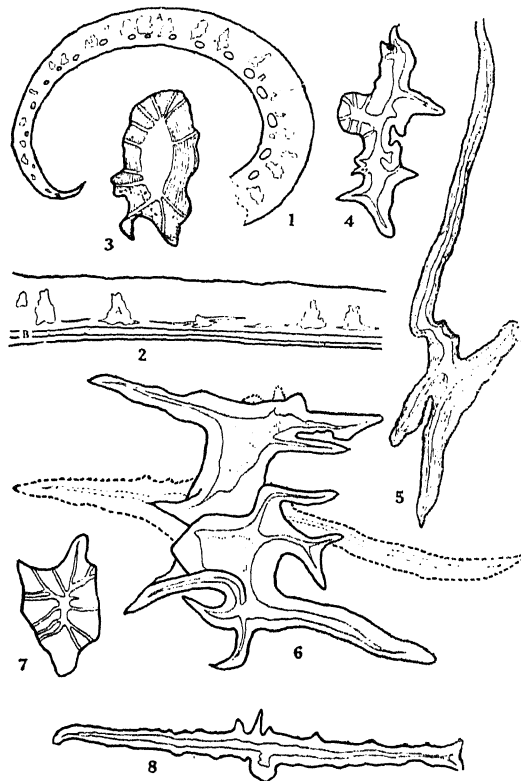
FIGS. 1–8. *Rhizophora mucronata* L. Fig. 1. T.s.t part of the stipule, × 14. Fig. 2. L.s. part of the stipule × 14. Figs. 3–5. 7 and 8. Sclereids. Fig 6. Two interlocked sclereids. Figs. 3, 6, 7, × 217 ; Fig. 4. × 170 ; and Figs. 5, 8, × 140. (A, strands of aggregate sclereids ; B, vascular strands).

The cytoplasm of the sclereid persists for a long time (Fig. 6). The cell walls show prominent concentric lamellation (Figs. 3, 5).

The shape of stipular sclereids of *Nymphea odorata*, according to Gaudet,[4] is affected due to the compact tissue of the stipule as they were of angular shape in cross-section instead of the typical circular. On the other hand the development and form variations are pronounced in the stipular sclereids of *R. mucronata*.

Univ. Dept. of Botany,   J. J. SHAH.
Sardar Vallabhbhai   K. P. SUNDARRAJ.
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Vallabh Vidyanagar,
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THE INHIBITION OF GIBBERELLIN-INDUCED ELONGATION OF RICE LEAF-SHEATH BY AUXIN

EXTENSION growth in several plants under stimulation by exogenous gibberellin is known to be promoted further by a simultaneous application of indole-3-acetic acid (IAA).[1] Either synergistic promotion[2,3] or additive effects[4] of IAA and gibberellin have been reported. As regards the gibberellin-induced stimulation of the elongation of monocotyledonous leaf-sheath on the intact plants this interaction has, however, not received much attention. In the excised leaves of wheat a synergistic effect between IAA and gibberellin in promoting elongation was found by Radley.[5] Recently Ogawa[6] has studied this aspect on rice leaf-sheath and reported that IAA had no influence on gibberellin-induced stimulation using a dwarf mutant, Tamanishiki.

In the present investigation a normal cultivated variety of rice (*Oryza sativa*, L. var. BCP. I) was used to study the interaction of gibberellic acid and IAA on the elongation in light of the second leaf-sheath in ten-day old seedlings.

The seeds were surface-sterilized, soaked for 24 hours in distilled water and were germinated in petri dishes. On the third day four uniform seedlings were transferred into each of 6″ × 1″ test-tubes on cotton wool and varying amounts of IAA or gibberellic acid or both in a total volume of 1·5 ml. distilled water were supplied. The controls received 1·5 ml. distilled water. The tubes were illuminated by a fluorescent lamp (100 lux). Length of the second leaf-sheath (mean of four seedlings) was measured seven days after the treatment. The results are shown in Table I.

The present results are in contrast with the mode of interaction of IAA and gibberellin in different plants hitherto reported inasmuch as the lack of either a synergistic promotion or an additive effect of IAA on the action of gibberellin in this case. The effect of IAA at concentrations that promote elongation when added alone did not become additive to that of gibberellic acid when supplied together. On the other hand a strong interaction was noticed between the two substances in all the concentrations tried ; the effect of IAA being inhibitory to the action of gibberellic acid.

TABLE I

The influence of gibberellic acid and IAA on rice leaf-sheath elongation: Length (mm.) of second leaf-sheath represents mean of three experiments

Gibberellic acid (μg/tube) IAA (μg/tube)	0	0·25	0·50	0·75
0	38·2±1·2	52·2±1·8	64·5±0·5	73·0±1·0
0·25	46·3±1·7	51·3±1·7	59·0±1·0	68·5±1·5
0·50	47·8±1·8	50·5±1·0	53·8±1·7	65·6±0·4
0·75	48·0±1·0	50·3±0·3	51·5±0·5	Not done

It appears that as long as the concentration of IAA is lower, the action of gibberellin is promoted and as concentration of IAA rises, gibberellin content should also increase to produce same degree of elongation counteracting the action of IAA. An exogenous application of gibberellin could bring an increase in the overall gibberellin status of the intact seedling over that of endogenous IAA, thus causing elongation. A simultaneous application of both the regulators will result in the control of gibberellin-induced elongation by the increased content of IAA. Further studies on the endogenous IAA-gibberellin balance in the intact seedlings will be most helpful in this direction.

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STOLON ROT OF JAPANESE MINT

A SEVERE disease of Japanese mint (*Mentha arvensis* Linn. Sub. sp. *haplocalyx* Briquet var. *piperascens* Holmes) was observed in Jammu Province during October 1963 at two different farms. In new plantations the disease is first observed during the month of May. The initial symptoms of the disease consist of yellowing of leaves and general stunting of the plants. In advanced stages, wilting of the entire plant

occurs followed by desiccation and death of the above ground portion. In case of severe infection even the underground stem dies resulting in thin crop stand and considerable decrease in yield. The main effect of the disease is evident on underground stolons. The symptoms on the underground stolons consist of pinkish-brown lesions in the earlier stage of the disease which gradually turn into dark brown-black patches. These lesions increase in size finally resulting into soft decay of the entire branch of the affected stolons.

A large number of isolations were made from infected stolons and wilted plants. Isolations from young lesions and infected plants mostly yielded Rhizoctonia whereas old and soft lesions gave a mixture of *Rhizoctonia* and species of *Fusarium*.

In order to test the pathogenicity, both dormant stolons as well as the intact potted plants were inoculated with various isolates. Stolons were inoculated by placing a drop of spore suspension or mycelial bit on a small wound made by a sterile scalpel To test the pathogenicity on intact plants, stolons were planted in steam sterilized soil. After about 8 weeks the plants were inoculated by pouring a suspension of mycelium and spores near the base of the plants, stolons of which were injured slightly with a scalpel.

Three different species of *Fusarium* isolated from decaying dormant stolons proved non-pathogenic both to dormant stolons as well as to potted plants. All the isolates of *Rhizoctonia* produced characteristic lesions on the stolons and also caused wilting of potted plants (Fig. 1). The fungus was re-isolated from all the inoculated stolons. Inoculation of intact potted plants during the month of July resulted in yellowing and wilting of the plants six days after inoculation. When the infected plants were removed from the pots and the soil washed away from the roots, most of the stolons and roots were found to be decayed by the fungus. Isolation from these rotten stolons gave a pure culture of *Rhizoctonia*. The isolate of *Rhizoctonia* which has been found to be pathogenic has been identified as *Macrophomina phaseoli* (Maubl) Ashby on the basis of pycnidial characters.

These observations prove that the stolon rot of Japanese mint in India is caused by *Rhizoctonia bataticola* (Taub) Butler [*Macrophomina phaseoli* (Maubl) Ashby]. A similar disease of peppermint (*Mentha piperita*) and spear mint (*Mentha spicata*) has been reported by Green[1] from United States. He isolated species of

Rhizoctonia and *Fusarium* from the diseased stolons. However, the pathogenicity of these organisms was not established, and this is the first report of the establishment of the casual organism of stolon rot of Japanese mint.

FIG. 1. Healthy and wilted mint plants inoculated with *Macrophomina phaseoli* (Maubl) Ashby.

The authors wish to express their grateful thanks to Mr. Sutton of Commonwealth Mycological Institute, London, for the help in identifying the fungus and to Dr. K. Ganapathi, Director, for facilities and encouragement.

Regional Research   AKHTAR HUSAIN.
    Laboratory,   K. K. JANARDHANAN.
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BACTERIZATION OF RICE AND OKRA SEEDS WITH *AZOTOBACTER CHROOCOCCUM* AND ESTABLISHMENT OF THE BACTERIUM IN THE RHIZOSPHERES

BACTERIZATION of seeds of some plant species with *Azotobacter* and its establishment in the rhizosphere have been studied by some workers.[1-6] The results obtained so far are not conclusive on the role of *Azotobacter* in plant rhizosphere. Studies were made by the authors to examine the possibility of establishing *A. chroococcum* in the rhizospheres of rice and

Okra (*Hibiscus esculentus*) by pre-treating the seeds with the bacterial culture and the results are reported here.

An isolate of *A. chroococcum* obtained from the Culture Collections of the Department of Agriculture, Annamalai University, was used in these studies. Surface sterilized rice and okra seeds were soaked for 18 hr. in a thick suspension in sterile distilled water of the bacterial cells. The suspension contained 82 million bacterial cells/ml. and after treatment the rice seeds carried 7,000 cells/gm. of seed on dry weight basis and the okra seeds 16,000 cells/gm. The treated seeds were dried in shade and sown in sterile or unsterile soil contained in 12 inch

pots. The soil was a clayey loam, with pH 7·2, collected from the University Experimental Farm. Both the treated and untreated seeds were sown in different sets of soils and the plants allowed to grow under identical conditions. The rhizosphere samples from each treatment were obtained at periodical intervals and the microbial population estimated following the procedure of Timonin.[7] The *Azotobacter* population was estimated using the nitrogen-free medium No. 77 (Allen[8]). The data on the *Azotobacter* population in rice rhizosphere are given in Table I and those of okra in Table II.

The results indicate that *A. chroococcum* could establish and multiply in sterile and

TABLE I

Azotobacter population in the rhizosphere of rice crop arising from seeds pre-treated with A. chroococcum

(Population expressed as 10^5/gm. of moisture-free soil)

Treatment		Age of the crop in days											
		10		20		30		40		50		60	
		P	R:S	P	R:S	P	R:S	P	R:S	P	R:S	P	R:S
Treated seeds sown in sterile soil:													
Rhizosphere	..	9·8		26·0		115·0		180·0		200·0		130·0	
			6·1		13·7		38·3		45·0		48·8		43·3
Soil	..	1·6		1·9		3·0		4·0		4·1		3·0	
Treated seeds sown in unsterile soil:													
Rhizosphere	..	2·5		20·5		85·0		96·0		123·0		88·0	
			2·1		11·4		34·0		36·9		41·0		35·2
Soil	..	1·2		1·8		2·5		2·6		3·0		2·5	
Untreated seeds sown in unsterile soil:													
Rhizosphere	..	1·8		10·8		18·5		23·0		28·0		30·6	
			6·0		27·0		30·8		33·0		35·0		33·3
Soil	..	0·3		0·4		0·6		0·7		0·8		0·9	

P = Population
R : S = Rhizosphere-Soil ratio

TABLE II

Azotobacter population in the rhizosphere of okra crop arising from seeds pre-treated with A. chroococcum

(Population expressed as 10^5/gm. of moisture free soil)

Treatment		Age of the crop in days											
		10		20		30		40		50		60	
		P	R:S	P	R:S	P	R:S	P	R:S	P	R:S	P	R:S
Treated seeds sown in sterile soil:													
Rhizosphere	..	12·0		64·0		220·0		215·0		167·0		75·0	
			12·0		35·6		55·0		52·4		47·7		37·5
Soil	..	1·0		1·8		4·1		4·1		3·5		2·0	
Treated seeds sown in unsterile soil:													
Rhizosphere	..	3·0		15·0		92·0		108·0		95·0		42·0	
			6·0		12·5		46·0		45·0		43·2		35·0
Soil	..	0·5		1·2		2·0		2·4		2·2		1·2	
Untreated seeds sown in unsterile soil:													
Rhizosphere	..	2·1		10·4		17·3		22·5		28·0		25·0	
			7·0		26·0		34·6		37·5		40·0		35·7
Soil	..	0·3		0·4		0·5		0·6		0·7		0·7	

P = Populaiton
R : S = Rhizosphere soil ratio

unsterile soils. It could also establish in rhizospheres of rice and okra, growing in sterile and unsterile soils. In the two rhizospheres *Azotobacter* population increased in the early stages and dropped after 50 days in rice and after 40 days in okra. In the untreated check plants there were fewer *Azotobacter* populations, which did not decline much with age of the plants. Also the *Azotobacter* population got more readily established in sterile soil and in the rhizosphere of plants growing in sterile soil than in the unsterile soil.

These results indicate that *A. chroococcum* could be established in plant rhizosphere through the seed. Being present in the rhizosphere region in considerable numbers, it could influence the plant growth either directly or indirectly. It is interesting to note, however, that the normal *Azotobacter flora* of the region did not reduce with plant age, whereas the introduced *A. chroococcum* reduced with age. These results appear to support the findings of Tribunskaya.[9] According to Clark[4] the *Azotobacter* population in tomato rhizosphere declined rapidly, whereas Daste[6] found that *Azotobacter* multiplied for sometime in the rhizosphere followed by a progressive decline. Zinoveva[10] and Nalivaiko and Romeiko[11] obtained results to support the establishment of *Azotobacter* in the rhizosphere of some plants. According to Federov and Tepper[2] the failure of *Azotobacter* inoculations in the rhizosphere is due to either insufficient excretion of carbonaceous materials from the roots or due to other unfavourable conditions for the growth of the organisms, the chief determining factors being the activity of the plant root system and the bacterial physiology. Studies on the influence of plant root excretions on *Azobacter* population are needed for a better understanding.

Microbiology Laboratory,   S. NEELAKANTAN.
Faculty of Agriculture,   G. RANGASWAMI.
Annamalai University,
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GALL INDUCTION ON *CYNODON DACTYLON* BY *USTILAGO*

Cynodon dactylon (Dubgrass) is the common lawn grass of Delhi. Generally its inflorescence comprises four digitate fascicles which are slender and smooth. In this area it is frequently found infected by *Ustilago cynodontis* (see also Chona et al.[2]). The fungus is systemic in the host but produces smut spores mostly in the inflorescence[1] which shows various degrees of transformation. Of the four fascicles only one, two or three may be attacked by the fungus. Occasionally only a part of the fascicle shows smut spores and the remaining part bears normal flowers (see Mehta[3]). The smut sori frequently extend to the stalk of the inflorescence and the flag leaf. In short, the reaction of the host to this fungus is extremely variable.

To this variety of responses, I wish to add a hitherto unrecorded response the formation of green galls in the inflorescence. Only the fascicles are involved in gall formation and the inflorescence axis and the flag leaf remain unaffected. Galls were noticed in a small patch of grass in the Delhi University Campus, during the rainy season of 1964. The specimens represented in Figs. 1–6 were collected on August 20, 1964. Figure 1 shows an infected inflorescence with the usual symptoms. All the four fascicles have retained their slender appearance and bear smut sori. In Fig. 2 only one of the fascicles is seen turned into a gall while the other three are underdeveloped and uninfected. Generally all the four fascicles are transformed into short and thick galls (Figs. 3, 6). Occasionally the tip of the inflorescence axis bears only three galls (Fig. 4). A gall is an oval structure (1–2 cm. long and 3–5 mm. in diameter) consisting of a few thick glumes enclosing a mass of teliospores. The glumes are leaf-like and are even differentiated into the sheath and the lamina (Fig. 3). The covering glumes separate from each other or degenerate at places (Fig. 6) thus exposing the spore mass for dispersal by wind. The gall represented in Fig. 5 is exceptional in that the fascicles and the glumes cannot be made out and the entire inflorescence is represented by

FIGS. 1 6.   Fig. 1. Infected inflorescence showing the usual symptoms of smut, all the four fascicles are linear and have been turned into smut sori.   Fig. 2. One of the fascicles is hypertrophied and has turned into a gall, while the other fascicles are reduced but do not show smut sori.   Fig. 3. The tip of the inflorescence axis bearing four galls; the glumes covering the galls are differentiated into the sheath and the lamina.   Fig. 4. Three galls at the tip of inflorescence axis.   Fig. 5. The entire inflorescence is represented by one elongated gall.   Fig. 6. Four galls at the tip of the inflorescence axis; the sori are dehiscing.

one elongated gall. It consists of a mass of spores covered by the host tissue.

The spores in these galls are around 7μ in diameter and show a smooth and thick episore, as is typical of *Ustilago cynodontis*.[4]

I am grateful to Professor P. Maheshwari for interest and encouragement.

Department of Botany,   HARDEV SINGH.
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REVIEWS AND NOTICES OF BOOKS

Physical Acoustics—Principles and Methods. Edited by Warren P. Mason. (Academic Press, Inc., 111, Fifth Avenue, New York-3.) Volume 1, Part A—*Methods and Devices.* Pp. xii + 515. Price $ 18.00.

Volume 1, Part A—*Methods and Devices,* 1964. Pp. xii + 376. Price $ 13.50.

This multi-volume work is intended to provide an integrated treatment of the techniques, applications, and analytical results obtainable by the use of physical acoustic methods. It describes high frequency sound waves in gases, liquids, and solids, and their uses as tools for analyzing the molecular, defect, domain wall, and other types of motions that can occur in these media. Low and high amplitude waves in these media are also described in their device applications, including such uses as delay lines for storing information, mechanical and electromechanical filters for separating communication channels, ultrasonic cleaning, testing inspection, measuring, machining, welding, soldering, polymerization, homogenizing, medical diagnosis, surgery, and therapy.

Volume 1, Part A, covers the propagation of infinitesimal and finite waves in fluids and normal solids, modifications caused by boundaries, transducers required to generate low and high amplitude waves, and methods for measuring the properties of such waves. Their uses in dispersive and non-dispersive delay lines, in mechanical and electromechanical filters, and in the control of the frequencies of oscillators and time standards are also presented.

Volume 1, Part B, deals with low and high amplitude uses of acoustic waves in inspection and processing. Methods for producing and utilizing hypersonic waves by means of piezoelectric semiconductors and cavity resonators are described. High frequency devices produced by semiconductor transducers of the depletion layer, diffusion layer, or epitaxial layer type are presented in their device applications and in the fundamental investigation of very rapid liquid and solid state motions. **C. V. R.**

Partial Differential Equations of Mathematical Physics, Vol. 1. By Tychonov and Smarski. Translated by S. Radding. (Holden-Day, Inc., San Francisco, California), 1964. Pp. 380. Price $ 11.75.

This text provides a thorough treatment of the partial differential equations of mathematical physics. The canonical forms of these equations are first derived and then followed by a discussion of their principal features. The study of each type of equation is motivated by its physical origins and the various methods for its solution are presented. The relations between some of these methods are also demonstrated. The questions of existence and uniqueness of the solution of an initial value or boundary value problem are carefully stated, together with their physical significance.

Each chapter contains worked-out examples which are drawn from different disciplines, and a wealth of problems to emphasize the methods developed. The text should appeal to the university students of mathematics, physics, engineering and chemistry, as well as to those who desire to be self-taught. It is unique in providing a smooth transition from the undergraduate level to the more advanced treatises of partial differential equations. It should also be welcomed by the experts as a convenient reference text. **C. V. R.**

The Proteins : Composition, Structure and Function, Second Edition, Vol. 2. Edited by Hans Neurath. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 802. Regular Price $ 26.00 ; Subscription Price $ 24.00.

The first volume of the second edition of this treatise was reviewed in *Current Science* in September 1964. The second volume is contiguous with the first, since it deals with the fundamental properties of proteins, both in solution and in the solid state. It contains five long chapters of which the authors and the subjects dealt with by them are the following. John A. Schellman and Charlotte Schellman have written on the conformation of polypeptide chains in proteins ; Jacinto Steinhardt and Sherman Beychok discuss the interaction of proteins with hydrogen ions and other small ions and molecules. The behaviour of interacting protein systems is dealt with in detail by L. W. Nichol, J. L. Bethune, G. Kegeles and E. L. Hess. Polyamino-acids considered as protein models are surveyed by E. Katchalski, M, Sela, H. I. Silman and A. Berger. The final chapter in the volume by Richard E. Dickerson on the X-ray analysis of protein structure presents a timely and penetrating account of a field of study which it is hoped will lead to the

solution of the basic problem of the fine structure of the protein molecule. Richly illustrated with X-ray diffraction pictures and diagrams of molecular structure, this last chapter will, in particular, be studied with great interest by a wide circle of readers.   C. V. R.

Variational Methods for the Study of Non-Linear Operators. By M. M. Vainberg. Translated and supplemented by Amiel Feinstein. (Holden-Day, Inc., San Francisco, California), 1964. Pp. x + 323. Price $ 12.95.

This book deals with the general theory of non-linear equations in real Banach spaces. The author first defines various forms of continuity and compactness for general non-linear operators, and then applies them to the study of the Gateaux and Frechet derivatives of operators. Following this, it is shown how the existence of solutions of operator equations is related to the existence of extreme points for certain associated functionals. This connection is further developed by considering conditionally critical and extreme points of functionals. These general results are then applied to various specific types of non-linear integral operators. The final chapter is taken from the book *Functional Analysis in Normed Spaces* by L. V. Kantorovich and G. P. Akilov; it deals with the application of Newton's method for obtaining approximate solutions of non-linear equations in Banach spaces. An appendix by the translator contains a resume of some basic facts from the theory of Banach spaces which are freely used by the author, as well as certain more special results which are needed in the chapter on Newton's method.   C. V. R.

Information and Information Stability of Random Variables and Processes. By Pinsker. Translated and annotated by Amiel Feinstein. (Holden-Day, Inc., San Francisco, California), 1964. Pp. xii + 243. Price $ 10.95.

Since its creation by C. E. Shannon, information theory has important applications in several branches of mathematics which could hardly have been anticipated at the time of its birth. We may mention the entropy variant in ergodic theory, which has settled several problems of long standing, the use of entropy concept in discussing various questions centered about Hilbert's thirteenth problem, Linnik's proof of the central limit theorem using the information functional, and a short proof of the equivalence-singularity dichotomy for Gaussian measures.

In this book the author develops the concept of information stability, which underlies several of the above-mentioned applications of the theory (as well as the classical coding theorems), and then applies it with particular reference to stationary processes and Gaussian processes. The treatment presupposes no familiarity with information theory, and special efforts have been made in this translation to include proofs for all results which are used, for which no suitable reference exists in English. Most of the results presented, of which many are due to the author himself, have appeared only in Russian scientific journals. Incorporated in this translation are numerous corrections by the author.   C. V. R.

Tensors in Mechanics and Elasticity. By Leon Brillouin. Translated from the French by Robert O. Brennan, S.J. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xviii + 478. Price $ 12.50.

In this book, Professor Brillouin covers the field in twelve chapters. In the first five chapters, the reader is led from elementary concepts of vectors to tensor algebra and calculus in affine space. In later chapters, after the introduction of metric and a study of differential operators in Riemann space, analytical mechanics is dealt with in tensor notation. The last three chapters concern themselves with the theory of elasticity, elastic waves in solids and the quantum theory of the solid state.   C. V. R.

Stability Constants of Metal-Ion Complexes. (Special Publication No. 17, The Chemical Society, Burlington House, London W. 1), 1964. Pp. xviii + 754. Price £ 8 or $ 23.

When the first edition of this useful book of tables was published by the Chemical Society in 1957-58 it was widely welcomed by chemists working in many different fields, as it brought out in two handy volumes essential data on the stability constants of metal-ion complexes, the sources of which were till then scattered in the literature. The importance of Complex Compounds not only in co-ordination chemistry but in such fields as analysis, catalysis, biochemistry and even biology, especially where trace concentration of metal ions are concerned, is being increasingly recognised and, looking at the rate at which investigations in these fields are mounting it is not surprising that copies of the first edition of this publication on Stability Constants have been depleted.

The present second edition promptly brought out by the Chemical Society is in one volume which in size is more than double that of the combined first edition. Section I on Inorganic

ligands has been compiled by L. G. Sillen, and Section II on Organic ligands by A. E. Martell. More material has been incorporated and the literature is covered completely up to end of 1960, and in some cases includes references up to 1963. A special feature of this second edition is the inclusion of material from Russian literature which was not available to the compilers at the time of the first edition.

A. S. G.

Soils of India. By S. P. Raychaudhuri, R. R. Agarwal, N. R. Datta Biswas, S. P. Gupta and P. K. Thomas. (Indian Council of Agricultural Research, New Delhi), 1963. Pp. x + 496. Price not given.

In 1942 the Indian Council of Agricultural Research sanctioned a scheme for collection, critical examination and collation of available data on the soils of India. These data were published as a bulletin in 1953. In 1952 the Council sanctioned another scheme for amplifying the data and bringing them up-to-date. The present publication *Soils of India* under review is based on the data collected up to the year 1960 under these two schemes.

The soils have been dealt with State-wise and accordingly there are 21 chapters in the book which include besides the 16 major States, Delhi, Pondicherry, Manipur, Tripura and Andaman and Nicobar islands.

The collected information includes geology, climate, vegetation, irrigation, soils—their fertility, characteristics, properties, structure, classification, reclamation, etc. Soil maps and rainfall maps have also been included.

The volume will be useful not only to research workers on soils but also to agricultural departments in the States and to general administrators and planners of land use and soil management programmes.

A. S. G.

Indian Woods, (Vol. 2)—*Linaceæ to Moringaceæ.* (The Manager of Publications, Delhi, for Forest Research Institute and Colleges, New Forest P.O., Dehra Dun), 1963. Pp. x + 366. Price Rs. 32·50 ; 75 *sh* ; $ 11.70.

The arduous but very useful undertaking by the Forest Research Institute and Colleges, Dehra Dun, to bring out under the title *Indian Woods* six substantial volumes which will contain comprehensive information on the woods of India, was widely welcomed when the first volume in the series was published in 1958. It dealt with 280 species. The present volume deals on the same lines with a further 263 species of Indian woods their identification, structure properties and uses.

The delay in publishing successive volumes in the series is understandable, because collection of authentic data involves the co-operation of a number of experts, institutes and laboratories not to speak of users of timber in various industries.

The volume deals with 23 families which include Linaceæ, Simarubaceæ, Burseraceae, Meliaceæ, Celastraceæ, Anacardiaceæ and Moringaceæ. There are 33 plates, each plate containing 6 end grain photomicrographs of timbers. Four appendices deal respectively with mechanical properties of woods, classifications according to anatomical structure, and uses, and latest changes in nomenclature.

A. S. G.

Advances in Clinical Chemistry, Vol. 6. Edited by H. Sobotka, and C. P. Stewart. (Academic Press, New York), 1963. Price $ 14.00.

This volume, the sixth in this series, covers subjects of topical interest.

"Micromethods for measuring Acid-base values of blood" describes the determination of acid-base of capillary blood, special attention being paid to the technique of pH determinations with a capillary electrode, and discusses the use of nomograms to facilitate calculation of the relevant acid-base values and registration of clinical results.

There is a wide gap in our knowledge of the role of magnesium in activating cellular enzymes and in intracellular transport. This has been partly due to the absence of a suitable technique to measure accurately and conveniently the magnesium concentrations. This difficulty is now overcome by the use of flame spectrophotometry. Absorptin, distribution and excretion of magnesium in the body, the functions of Mg, its osmotic role, influence on enzyme systems, nerve conduction and muscular contraction, clinical effects of magnesium imbalance and methods for the determination of magnesium in biological materials are presented in the review on 'Magnesium'. The technique of flame spectrophotometry to determine magnesium concentration is explained.

The article 'Enzymatic determinations of glucose' is primarily concerned with enzymatic measurements of glucose with glucose oxidase and reviews the properties of this enzyme, clinical test systems for measurements of glucose in urine and blood, and possible applications of this enzyme to other fields of study.

Amongst the inherited metabolic disorders, the study of inborn defects in the metabolism of phenylanine and tyrosine has provided a

wealth of information for the development of biochemical genetics and the concept of molecular diseases. The comprehensive review on phenylalanine and tyrosine metabolism deals with the clinical features, pathology and biochemical aspects of phenyl ketonuria, tyrosinosis and allied disorders, alkaptonuria and albinism. Besides presenting simple laboratory procedures for the diagnosis of these diseases, the author has highlighted the implications of these studies in the wider context of many other types of clinical disorders.

The discovery of a specific foetal hæmoglobin in newborn babies and demonstration of abnormal hæmoglobin in methemoglobinæmia and sickle cell anæmia, has opened up an entirely new field of study. The study of hæmoglobin variants in recent years has been directed towards search for abnormal types and distribution of these variants in the world and of their anthropological significance ; refined techniques for the detection and quantitation of normal and abnormal minor hæmoglobin components ; elucidations of the complete structures of some hæmoglobin types and of the functional properties of hæmoglobin variants. 'Normal and abnormal human hæmoglobins' is a chapter which presents the developments in all these fields of study and discusses exhaustively the physiological and clinical aspects of the human hæmoglobin types.   M. SIRSI.

Easy German Course (for Arts and Science Students). By Dr. Haragopal Biswas, Calcutta University. (The World Press, Private Ltd., Calcutta), 1963. Pp. xv + 378. Price Rs. 12·00 (18 *sh.* net).

Dr. Biswas, who is an experienced teacher of German language and the author of the books, *German Primer for Science Students,* and *Progressive German Reader for Arts and Science Students,* previously published, has now brought out the present volume for the benefit of students of all categories, wishing to acquire a sound knowledge of this foreign language.

The book is divided into three main sections, dealing respectively with grammar, lessons on literary topics, and lessons of scientific interest. In the grammar section the author has made an elaborate treatment of the essentials of German grammar ; for, German like Sanskrit cannot be properly mastered without a thorough knowledge of its rather complicated grammar. The lessons for the literary and scientific sections have been judiciously selected, and are both appropriate and instructive. These further include biographical sketches of some eminent

scientists in the latter section. Each lesson is provided with its own vocabulary, besides a general vocabulary added at the end.

The book, in the opinion of the reviewer, will not fail to serve as a very good German Self-taught and can be whole-heartedly recommended for the purpose.   P. RAY.

Books Received

From : (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York):

The Direct Observation of Dislocations—Solid State Physics (Supplement 6). By S. Amelinckx, 1964. Pp. x + 487. Price $17.00.

Glass Ceramics. By P. W. McMillan, 1964. Pp. viii + 229. Price 47 sh. 6 d.

Advances in Lipid Research (Vol. 2). Edited by R. Paoletti and D. Kritchevsky, 1964. Pp. xi + 499. Price $16.00.

Quadratic Forms and Matrices—An Introductory Approach. By N. V. Yefimov, 1964. Pp. ix + 164. Price $2.45.

Finite Permutation Groups. By H. Wielandt, 1964. Pp. x + 114. Price $2.45.

Non-Euclidean Geometry. By H. Meschkowski, 1964. Pp. viii + 104. Price $2.45.

Elements of Abstract Harmonic Analysis. By G. Bachman, 1964. Pp. xi + 256. Price $3.45.

Introduction to p-Adic Numbers and Valuation Theory. By G. Bachman, 1964. Pp. ix + 173. Price $3.45.

Hormonal Steroids. I. Biochemistry Pharmacology and Therapeutics. Edited by L. Martini and A. Pecile, 1965. Pp. xx + 587. Price $18.00.

Nuclear Science and Technology (Vol. 3)— *Numerical Methods of Reactor Analysis.* By M. Clark Jr. and K. F. Hansen, 1964. Pp. xi + 340. Price $10.50.

Experimental Biology (Vol. I)—*Introduction to Thermodynamics.* By D. C. Spanner, 1964. Pp. xii + 278. Price 47 sh. 6 d.

Advances in Hydroscience (Vol. I). Edited by Ven Te Chow, 1964. Pp. x + 442. Price $15.00.

Local Analytic Geometry. By Shree Mam Shankar Abhyankar, 1964. Pp. xv + 484. Price $18.00.

The Solubility of Non-Eelectrolytes. By J. H. Hilderbrand and R. L. Scott. (Dover Publications, 180, Varick Street, New York-14), 1964. Pp. xiv + 488. Price $2.50.

Electronic Processes in Ionic Crystals. By N. F. Mott and R. W. Gurney. (Dover Publications, New York-14), 1964. Pp. xii + 275. Price $2.00.

Structure of Molecules and the Chemical Bond. By Y. K. Surkin and M. E. Dyatkina. (Dover Publications, 180, Varick Street, New York), 1964. Pp. ix + 509. Price $2.75.

SCIENCE NOTES AND NEWS

Tropical Pastures Research

The IX International Grasslands Congress, held at Sao Paulo, Brazil (January 7 to 21, 1965), passed at its final plenary session business meeting a resolution recommending that FAO establish an *International Tropical Grassland Commission* to co-ordinate research in Tropical Pastures, suggest appropriate priorities and promote promising activities and co-operate efforts among the Tropical countries in pasture research and development.

Any suggestions may please be sent to : (1) Professor G. S. Puri, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana and (2) Dr. R. A. Peterson, FAO, *via* della Terme di Caracales, Rome (Italy).

Inverse Raman Spectra: Induced Absorption at Optical Frequencies

According to theories of dispersion incoherent scattering of radiation manifests itself both in *emission* and in *absorption*. Up to the present time, all investigations of such processes, including Compton scattering, the normal Raman effect, or the recently discovered stimulated Raman scattering (SRS), have been concerned with the *emission* of the scattered radiation and its spectrum. B. P. Stoicheff and W. J. Jones have reported spectroscopic evidence for the *absorption* occurring during incoherent scattering at optical frequencies.

In the experiment the scattering medium (liquid benzene for example) was irradiated simultaneously with intense monochromatic light of frequency ν_0 (from a giant-pulse ruby maser) and with an intense 'continuum' of suitable frequency range (provided by a maser-irradiated toluene cell q.v.). Under this excitation the benzene molecules are stimulated to emit radiation at ν_0 and at the same time to absorb radiation at $\nu_0 + \nu_M$ (or $\nu_0 - \nu_M$) from the 'continuum', the net effect being to change their energy states by $+ h\nu_M$ (or $- h\nu_M$). The spectrum of the 'continuum' after it traverses the medium shows very strong absorption lines at $\nu_0 + \nu_M$, the frequency displacements ν_M corresponding to known Raman shifts for the scattering medium.

The observed spectrum is similar to the well-known reversal of spectral lines in atomic spectra, but in the present case as the absorption spectra arise from the stimulated scattering process they are called the "inverse Raman spectra" (IRS).

Spectroscopic studies of stimulated Raman radiation have shown that when the maser emission is a single sharp spectral line, all of the Raman lines are sharp. But if the maser emission contains additional components (even differing by $< 1 \text{ cm.}^{-1}$), the Raman emission lines get considerably broadened, sometimes up to several 100 cm.^{-1} This fact was made use of to furnish the 'continuum' in the present experiment. Maser radiation was first incident on liquid toluene contained in a cell. This produced intense stimulated Raman emission at $\nu_0 + 1003 \text{ cm.}^{-1}$ of sufficient width that it (the toluene 'continuum') extended to the region of the benzene anti-Stokes line at $\nu_0 + 992 \text{ cm.}^{-1}$, which appeared as a sharp prominent absorption in the experiment.

Similar absorption spectra were observed with liquid pyridine ($\nu_0 + 990 \cdot 2 \text{ cm.}^{-1}$) and liquid nitromethane ($\nu_0 + 917 \cdot 8 \text{ cm.}^{-1}$).

Investigations of inverse Raman spectra are potentially of great importance in molecular spectroscopy. With improvements in techniques, it should be possible to investigate the IRS of gases, liquids, and solids, including rotational and electronic transitions in addition to the vibrational transitions. High speed Raman spectroscopy of interest in the study of free radicals and other short-lived species may be possible. Finally, since the inverse spectrum is so intimately related to the stimulated emission spectrum, its study may help in a quantitative understanding of the SRS which in emission is overlapped by higher order and parametric effects.—*(Phys. Rev. Letters*, November 30, 1964.)

Compton Effect on Moving Electrons

Until recently only the Compton effect on electrons at rest has been investigated. Modern giant accelerators make it possible to investigate the scattering of photons by electrons moving with speeds near to the speed of light. Radiation from powerful lasers can be used to study the Compton scattering of visible photons by moving electrons of a cyclic accelerator.

The interaction of laser photons with relativistic electrons has been theoretically studied. According to these studies a head-on collision of laser radiation ($\lambda = 6943 \text{ A}$) with relativistic electrons of energy 500 MeV, will cause the appearance of γ-quanta of energy $\sim 6 \cdot 75 \text{ MeV}$,

moving in the direction of motion of the electrons.

The experiment to test the above theoretical deduction was carried out at the Lebedev Physical Institute, Moscow University, using the 600 MeV synchrotron facility. The results of preliminary experiments give positive evidence for Compton scattering of laser photons by relativistic electrons during a head-on collision of the beams resulting in the appearance of gamma radiation.

This effect can be of importance for diagnostics of electron clusters; also the scattered γ-quanta may be used in various aspects of nuclear research.—[*Physics Letters*, 1964, 13 (4), 344.]

Gamma-Ray Astronomy

During the past two decades conventional optical astronomy that has been with us for centuries has expanded to include radio and radar astronomy. But even these branches were unable to overcome the limitations imposed by the terrestrial atmosphere which absorbs most of the cosmic radiation.

Space probes and orbital satellites carrying instruments for investigations of gamma-rays and X-rays originating in the cosmos have set the beginning of two more branches of astronomy, namely, gamma-ray astronomy and X-ray astronomy. X-rays in cosmos are associated with the formation of a neutron star after a supernova explosion (*see Curr. Sci.*, 1964, 33, 510).

Interstellar gamma-rays may be thought of as produced by several mechanisms. One of them is the collision of two high-energy protons. Another mechanism is the annihilation process in which a particle and its "antipode" meet and convert spontaneously into gamma-ray photons. A third mechanism is by the action of relativistic electrons (*i.e.*, electrons moving with a speed close to that of light) on photons, *vide supra*. When a high energy electron runs into a photon of low energy, it imparts to the latter some of its energy and the photon becomes a hard photon of high energy, *i.e.*, a gamma quantum.

Currently astronomers are busy unravelling the mystery of a recently discovered supernova entered in astronomical catalogues as object 30273-B whose brightness is about a hundred times more than that of our galaxy. According to Soviet astronomer Vitaly Ginzburg this supernova besides being a powerful source of light

emission is also a strong source of gamma-rays. —(Courtesy : *USSR News*.)

Higher Yields by White Maize Hybrid Ganga Safed-2

Messrs. K. K. Mandloi, S. K. Dubey, S. K. Nigam and P. K. Tiwari, Maize Breeding Research Station, Chhindwara, M.P. write :

Results of field trials conducted during the past three years have shown that the white maize hybrid *Ganga Safed-2* produces higher yield than *Sumeri*—a white seeded local variety popular in certain districts of Indore. According to these trials the white hybrid *Ganga Safed-2* has given, on an average, extra yields of 379 and 952 kg./hectare under low (45 kg. N/hectare) and high (150 kg. N/hectare) fertility levels respectively. These trials were also given a common basal dose of 50 and 35 kg./hectare of P_2O_5 and K_2O respectively.

Arnebia hispidissima DC.—A New Record for Bihar State

K. Thothathri, Central National Herbarium, P.O. Botanic Garden, Howrah, writes :

Arnebia hispidissima DC. was collected in the Udaipur forest, Champaran District, Bihar, during a botanical exploration tour in April 1963. This species has not been recorded either in *The Botany of Bihar and Orissa* by Haines (1922) or its *Supplement* by Mooney (1950). A careful scrutiny of the various literature dealing with the flora of Bihar as well as specimens of the said species in the Calcutta Herbarium revealed that the occurrence of this plant in Udaipur forest, Champaran District, constitutes a new record for Bihar State.

Journal of Experimental Social Psychology

Researches in various areas of social psychology and group behaviourism are being carried on at scientific levels in different centres and the experimental results far from being empirical only can now be co-ordinated to give a theoretical orientation which will help further research. In this context we welcome this new quarterly published by Academic Press, Inc. The First issue Vol. I, No. 1, January 1965, contains the following articles : The Roles of Information, Discussion, and Consensus in Group Risk-Taking ; Collective Behaviour in a Simulated Panic Situation ; Experiments on the Alteration of Group Structure ; The Requirements and Design of a Standard Group Task ; The Development of Contractual Norms in a Bargaining Situation under Two Types of Stress.

THE NEW PHYSIOLOGY OF VISION

Chapter XIII. Blue, Indigo and Violet in the Spectrum

SIR C. V. RAMAN

THE studies of colour in the spectral range between 5000 and 4000 angstroms at various levels of brightness made by the author and presently to be described have yielded results of great interest. It is found that the basic sensation excited by radiations falling anywhere within this spectral range is that of violet. In other words, light everywhere in this spectral region exhibits a violet colour if its brightness does not much exceed the minimum needed for the perception of sensible colour. As the intensity is increased, the violet passes over at a fairly definite level of brightness to a sensation which may aptly and correctly be described as indigo. At a still higher level of brightness, the colour changes over to a bright blue colour. These remarkable results have been established using several different techniques of observation which will be set out fully as we proceed. All the three colours, viz., blue, indigo and violet may be perceived following each other in the order stated in the spectrum of continuous radiation if this has the appropriate intensities.

Another result of great interest which has emerged from the present investigation is that in the spectrum of \continuous radiation, three maxima of luminosity separated by regions of lower brightness may be observed visually. The positions of these maxima have been located at 470 mμ, 435 mμ and 410 mμ. These maxima of visual brightness appear in the same positions as the known maxima of absorptive strength in the spectrum of the visual pigment xanthophyll functioning in this region of the spectrum.

Techniques of Observation.—One of the simplest methods for the study of the colour-luminosity relationship in the spectrum is visual observation with the aid of a replica diffraction grating of the light from the linear source furnished by an opening between the wooden shutters of a darkened room. The observer holds the grating before his eye and scans the diffraction spectra seen in his field of view. The best time for such observations is in the early morning hours ; the window should face eastwards, so that a strip of the brilliantly luminous sky in the vicinity of the sun is seen through the opening between the shutters. At that hour, owing to the rays of the sun having traversed a great depth of atmo-sphere, light having the shortest wavelengths is much attenuated. Examination with a pocket spectroscope shows a rapid falling off in brightness between 450 mμ and 430 mμ and no observable intensity at smaller wavelengths. But the observations can also be made at other times when the spectrum extends to lower wavelengths.

The width of the opening and the distance of the observer from it may both be adjusted so that the diffraction spectra have adequate intensity and at the same time exhibit adequate resolution and dispersion. A further device which is extremely useful is for the observer to place immediately before the diffraction grating, a colour filter of gelatine film dyed with "disulphine blue". (The preparation of such filters will be described fully in a later chapter.) This filter effectively cuts off the red, orange and yellow of the spectrum and allows only wavelengths less than 560 mμ to reach the eye of the observer. Apart from making it easier to observe the colours in the rest of the spectrum without dazzle or interference, the cut-off of wavelengths greater than 560 mμ prevents the overlap of the diffraction spectra of higher orders with each other. It then becomes possible to study the colours exhibited between 500 mμ and 430 mμ not only in the first-order diffraction spectrum but also in the second-order and third-order spectra. These are, of course, of much lower intensities.

Results of the Study.—With the arrangements described above, it is found that the appearance of the spectrum in the region following the green sector is altogether different in the first, second and third-order diffraction spectra. The intensity of the spectra can be controlled by varying the width of the opening between the shutters, the observer retaining his position at a convenient distance from it. It is best to adjust the luminosity so that the third-order spectrum is just sufficiently bright for it to be clearly perceived. The first-order spectrum then exhibits a blue colour between 490 mμ and 460 mμ and an indigo between 460 mμ and 430 mμ. In the second-order spectrum, on the other hand, the blue is unobservable and the region between 490 mμ and 430 mμ exhibits the indigo colour. The third-order spectrum exhibits a violet hue over the entire region.

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Very similar results are obtained using the artificial light source provided by a tubular lamp with a tungsten filament stretched along its axis and heated by an electric current. The observer views the diffraction spectra of different orders of this light source with a replica grating and the "disulphine blue" colour filter held before his eye. The luminosity of the spectrum may be quickly and rapidly controlled by moving the slide on the rheostat which varies the current heating the tungsten filament. The same result can also be achieved by the observer moving away from or towards the lamp. The entire sequence of changes in the colour exhibited over the whole spectral change can thus be quickly and conveniently followed.

Still another procedure which enables the colour-luminosity relationships to be studied in a quantitative fashion is to observe the spectrum of the continuous radiation of a tungsten-filament lamp through a wavelength spectrometer. A coiled-coil filament lamp giving a brilliant white light of the type used in projection work is very suitable for such observations. A sheet of opal glass placed immediately in front of the slit of the spectrometer helps to diffuse the light entering the instrument and enables its full aperture to be utilised. By moving the light source away from the opal-glass sheet, the level of illumination in the spectrum under observation can be varied over a great range in a calculable fashion. The observer can then view the spectrum in the focal plane of the instrument through an eyepiece and follow the changes in the colour sequence as the lamp is moved away from the opal-glass sheet. It will be noticed that the blue part of the spectrum progressively contracts, being replaced by the indigo and finally by the violet colour which is the basic hue of the spectrum throughout the wavelength range between 500 mμ and 400 mμ.

Observations with Sunlight.—If sunlight is admitted into a darkened room through a narrow slit and the emerging pencil of rays after traversing a dense flint-glass prism of 60° angle is received on a white screen placed at a suitable distance, one observes the solar spectrum after the manner of Newton. The differences in colour between the blue, indigo and violet regions in the spectrum then observed are so very striking that one can only wonder why later writers have not accepted Newton's description of the colours of the spectrum. Had they taken the trouble to repeat Newton's experiments making use of the high luminosities made possible by sunlight, they would have

realised that his description was entirely accurate. Incidentally, it should be remarked that in the spectrum seen under these conditions, the maximum visual brightness appears in the yellow region and not in the greenish-yellow.

The spectrum of sunlight can also be exhibited in a spectacular fashion with the aid of a diffraction grating having a large ruled area. Sunlight reflected by a heliostat enters a darkened room through an aperture of area 10 cm. $\times$ 5 cm. and after the beam has traversed a distance of two metres it is incident on a replica diffraction grating with a ruled area also of the same size (10 cm. $\times$ 5 cm.). The first-order diffraction spectrum resulting from the passage of the light through the grating is received on a white screen eight metres away from the grating. It is then seen as a brilliant band of colour stretching over a length of 150 centimetres. In the region of shorter wavelengths, three regions are noticed of which the colours are quite different and readily distinguishable from each other, *viz.,* blue, indigo and violet.

Instead of allowing the spectrum to diverge from the grating and fall on a distant screen, a more satisfactory arrangement is to use a telescopic objective of sufficient aperture (15 cm.) and of sufficiently great focal length (400 cm.). The first-order diffraction spectrum is brought to a focus by the objective and the intensity and the definition of the spectrum are thereby greatly improved. The spectrum is received on a ground-glass screen and is viewed by the observer. By covering up the ruled area of the diffraction grating, its aperture may be progressively reduced from ten centimetres down to a millimetre and the brightness of the spectrum is thereby proportionately reduced. Remarkable changes are then noticed in its colour. When the full aperture of the grating is functioning, the blue region covers the greater part of the spectrum between 500 mμ and 400 mμ, the indigo and the violet occupying only small parts near the end. As the luminosity is diminished, the blue progressively contracts and ultimately disappears, being replaced by the indigo and then by the violet. In the final stages, the entire spectrum after the green exhibits a violet hue.

Colours in Line Spectra.—The light emitted by the radiating atoms is localised in their spectra and appears as sharply defined lines. When these lines are observed visually through a dispersing apparatus, they would generally appear to be of much greater intensity than any continuous spectrum accompanying them.

The colour-luminosity relationship would then make itself felt as an observable difference between the colour of the spectral line and of the continuous spectrum on either side of it. Such a difference is conspicuously exhibited by the λ 4358 line in the spectrum of the mercury vapour lamp when there is an accompanying continuous spectrum. It appears of a bright blue colour, while the continuous spectrum on either side exhibits a violet hue resembling that of the λ 4046 radiation.

Spectral lines of low intensity in the region between 500 mμ and 400 mμ may exhibit colours different from those normally to be expected in that region. This phenomenon may be observed in the spectrum of a sodium vapour lamp soon after it is started, when feeble emission lines of gas atoms other than sodium are also present. Lines appear which exhibit a violet hue instead of the blue colour to be expected from their positions relatively to the stronger lines.

Origin of the Three Colours.—The foregoing recital of the actual facts of observation leaves us with some questions which need to be answered. Why are three colours readily distinguishable from each other exhibited in the spectral range under consideration? Why do the colours alter when the level of brightness is varied? Some light is thrown on the issues here raised by a few further observations presently to be described.

The absorption spectrum of xanthophyll has already been described in detail in an earlier chapter, but it may be briefly recalled here. The absorption increases from zero at 520 mμ to a substantial value at 500 mμ. It then rises steeply and exhibits a pronounced maximum at 476 mμ. It then dips down to a minimum, beyond which it recovers and exhibits a second and even more pronounced maximum at 447 mμ. Thereafter, there is a fall which is however interrupted by the appearance of a third but less pronounced maximum at 420 mμ. There is then a continuously diminishing absorption as we pass from the visible to the ultra-violet region.

These various features show a close relationship to the visually perceived features in the same range of the spectrum. It has already been remarked that the first steep rise in absorption around 490 mμ occurs precisely where the observed colour of the spectrum changes rapidly from green to blue. In the present study, a further remarkable parallelism has come to light. This is the appearance of bands of higher luminosity in the spectrum which coincide in their respective positions with the absorption maxima of xanthophyll. To observe these bands, the same technique is employed as that described earlier for the studies of colour in this region. The observer views the first-order diffraction spectrum of a luminous tungsten filament produced by a grating held before his eye. The bands commence with a noticeable fall in luminosity in the spectrum where the green ends and the blue begins. Following this, a bright band with a maximum of intensity at 470 mμ is readily recognisable. A further drop in luminosity is followed by a recovery and a second maximum of brightness at 435 mμ is noticed. Beyond this again, there is a further drop in intensity followed by a recovery in which the third and last maximum at 410 mμ is discernible. The first maximum at 470 mμ falls in the blue region, the second maximum at 435 mμ in the indigo and the third maximum at 410 mμ appears in the violet.

These facts of observation suggest that the reason why three distinct colours manifest themselves to our visual perceptions in the spectral range between 500 mμ and 400 mμ is just that the absorption spectrum of xanthophyll has three maxima in this spectral range, these three maxima covering the regions in which the three colours respectively appear. This, however, leaves unanswered the question why the perceived colours alter with the level of brightness in the spectrum. But such alterations are not altogether unexpected. In the preceding chapter, we have noticed that the colour sensations which are experienced in the spectral range between 5000 and 6000 angstroms are strongly influenced by an increase in the level of luminosity. It need not therefore surprise us to find that in the adjoining spectral region between 4000 and 5000 angstroms, changes in the level of luminosity also produce striking changes in the colour sensations. That they are of a different nature need not also surprise us. For, in the former case, the visual pigments which function are heme and its derivatives which are biological products of human metabolism, whereas in the latter, it is the carotenoid pigment xanthophyll, a plant material which has found its way into the human body by way of food products consumed. In the two cases, we are dealing with the pigments which differ profoundly in their chemical structure as also in their spectroscopic behaviour.

INTERNATIONAL CONFERENCE ON MAGNETISM AT NOTTINGHAM

R. VIJAYARAGHAVAN

Tata Institute of Fundamental Research, Bombay-5

THE International Conference on Magnetism was held at the University of Nottingham, Nottingham (U.K.), between the 7th and the 11th September, 1964. It was arranged by the Institute of Physics and the Physical Society under the auspices of the International Union of Pure and Applied Physics. Nearly three hundred scientists participated in the proceedings of the Conference. The subject discussed were far too numerous and could be broadly classified under the following headings : Nuclear magnetic resonance, Resonance and relaxation, Metals and alloys, Neutron diffraction, Covalency and exchange effects, Thin films, Ferro and anti-ferro-magnetism, Ferrite, Fermi surfaces, Spin waves, Garnets, Hematite and Magnetisation processes. The discussions were held in two parallel sessions and it will not be possible to cover all of them here. So we restrict ourselves to selected topics in this report.

Prof. Jaccarino (U.S.A.) reviewed the NMR studies of transition metals. It is only in recent years that our knowledge of the statistical character of the electronic properties of transition metals has been supplemented by measurements of the local charge and spin densities. This has become possible due to NMR, Mossbauer effect and Neutron scattering techniques. Jaccarino explained how the knight shifts and relaxation times in transition metals give valuable information on the complex band structures. The knight shift in dilute alloys is of great interest to physicists. For example, it is known that the magnitude and temperature dependence of the susceptibility of palladium is reduced by the addition of small amounts of vanadium. The knight shift of ^{51}V in palladium alloys with as little as 0.1% vanadium indicates that the local d spin susceptibility becomes vanishingly small as can be inferred from its lack of temperature dependence. These results complement the neutron scattering work on the magnetisation density around a vanadium impurity in the isomorphic V-Ni alloys. Simple band theory explains the decrease of the magnetisation of cobalt or nickel alloys with non-magnetic metals like copper because the d holes are filled by the electrons of copper. Prof. Itoh (Japan) illustrated it with the examples of ferromagnetic alloys using nuclear magnetic resonance. There were two papers on

NMR in platinum alloys. Platinum, a transition metal with an atomic configuration $5d^9$ $6s$, gives a negative shift which is attributed to the unfilled d bands. The author showed how the relative filling of d band reduces the shift as well as the susceptibility in platinum alloys. In fact, it is possible to obtain a linear relationship between susceptibility and shift in platinum alloys. Dr. Froideveaux (France), studying Pt-Au system, explained that the d electrons are primarily responsible for shift whiles electrons play a dominant role for the exchange interaction. It became evident from these discussions that the NMR is playing a vital role in understanding metal physics.

Prof. Low (U.K.) concerned himself with the electronic structure of disordered ferromagnetic alloys using neutron diffraction technique. It allows more detailed information in dilute alloys, about the electronic structure ; as the minor constituent atoms of a binary alloy can be investigated in isolation in the solvent metal. Under these conditions, knowledge may be obtained not only of the magnetic moment at the solute atom sites, but also of the moments at sites intermediate between these and regions of the host material that remain unperturbed. Magnetic structure investigations at Grenoble formed the subject-matter of an interesting talk by Prof. Pauthenet (France). He reported two new rare-earth manganese oxide compounds, hexagonal R.E. MnO_3 which is ferroelectric, antiferromagnetic and weakly ferromagnetic below $46°$ K. ; and orthorhombic R.E. Mn_2O_5 which has no ordering down to $4°$ K. Saclay group presented an interesting paper which described neutron diffraction experiments on superconducting niobium. These experiments have demonstrated for the first time the ordered structure of magnetic field in hard superconductors.

The covalency effects observable in several magnetic salts from neutron diffraction experiments were discussed in great detail. Professor Nathans (U.S.A.) compared the results obtained by NMR and neutron diffraction techniques in such cases and reported satisfactory agreement between the two. Dr. Freeman (U.S.A.) described in great detail the role of covalency in crystal field theory specifically in iron series salts. Dr. Rimmer (U.K.) concerned himself

with a discussion on the merits of several theoretical approaches to the covalency problem.

Nearly a full day was devoted to thin films study. In order to under tand the magnetic characteristics of thin films which differ from those of bulk specimens, magnetic domain and domain wall structures of single crystal thin films of typical ferromagnetic substances have to be studied. Dr. Sato (U.S.A.) investigated single crystal films of Fe, Ni and Co and obtained the following conclusions : (1) As the thickness of films decreases, the domain structure becomes smaller in size and more sensitive to the imperfections in substrate. (2) Due to the lack of demagnetising field in the film sufficient to orient the surrounding domains, the domain patterns are usually irregular. In addition, closure domains over the entire films are usually not found. There were some interesting papers on spinwave theory as applied to thin films. Using the theory, the magnetic properties of thin films of Fe and Ni were studied to understand the explicit form of spin waves, possible resonance peaks in spin wave resonance experiments and the question of their observation in a homogeneous r.f. field. The mathematical form of anisotropy had been put to test experimentally. The effect of a possible "red shift" of spin waves was also indicated.

A large number of papers in the Conference could be grouped under the heading "metals and alloys". That explains why nearly two days were devoted to this all-embracing topic. Dr. Matthias (U.S.A.) gave an illuminating talk on conduction electrons and ferromagnetism. The role of these electrons in the occurrence of ferromagnetism is hard to assess. There are possibly as many experiments to support its importance as there are to contradict it. Matthias concludes, after conducting careful experiments, that, sometimes the expected conduction electron interaction responsible for ferromagnetism does not occur. However, it may occur, where least expected, such as in intermetallic compounds of superconducting elements where interaction between free electrons is strong enough to result in ferromagnetism. This session was particularly interesting for wide variety of topics discussed under the general heading of metals and alloys.

On the final day of the session, the properties of rare-earth metals and garnets were discussed. Dr. Kasuya (Japan) discussed the various characteristics of rare-earth metals, including

non-magnetic metals like Sc, Y, La and Lu, on an s-f exchange model and a plausible band structure for the conduction electrons. It is gratifying to see a satisfactory agreement between theory and experiment. Prof. Belov (U.S.S.R.) reported the measurements of the magnetic, galvanomagnetic, and magnetostrictive properties of gadolinium, terbium, Gd-Yttrium and Tb-Yttrium alloys, obtained at the Physical Department of the Moscow State University. He hoped that a proper understanding of the data would help to solve the problem of the existence of antiferromagnetism in gadolinium. Dr. Koehler (U.S.A.) described the neutron scattering experiments conducted on rare-earth metals and compounds at the Oak Ridge Laboratory. The experimental data obtained by this group are quite staggering but, when one takes into account of their potentiality for doing great experiment, this comes as no surprise to anyone.

This report cannot be a complete summary of the Proceedings. Only a fraction of the total number of papers could be touched here. The Magnetism Conference, as we all know, is held usually every three years. The Proceedings of the Conference, in early days, covered only the experimental and theoretical work on the bulk magnetism. After the war, with better tools at the hands of the physicists like neutron diffraction, Mossbauer effect and NMR, the emphasis has shifted to the study of the microscopic nature of materials. This has resulted in an enormous amount of precise experimental work, performed simultaneously in several parts of the world, with theorists struggling to cope with an avalanche of experimental data. The Conference, under such circumstances, tends to become very broad in outlook and naturally the topics become diverse. Even with such diversity the Conference at Nottingham was brilliantly organised, thanks to the great leadership. given by Prof. L. F. Bates of the University of Nottingham, who has done much more than most men in this field to the understanding of magnetism. Its success in itself is a tribute to Prof. Bates, at the time of his well-merited retirement. We missed Profs. Néel and Gorter, the other giants in this field, but this was compensated in a way by the presence of Prof. Van Vleck, who, in spite of his age, takes a lively interest in the Physics of today. The author would like to conclude this report by saying that it is a unique experience to be present in a Conference of such huge dimensions.

THEORETICAL CONSIDERATIONS ON THE VALUE OF COAL PETROGRAPHY IN COKE STUDIES OF CHIRMIRI COAL (M.P.), INDIA

S. K. BABU* AND A. R. CAMERON**

INTRODUCTION

THIS short communication describes a simplified application of coal petrography, whereby the reflectance measurements can be used to estimate and evaluate the coke strength. Several theoretically calculated stabilities of the coals of Chirmiri with blends of American coals are presented as examples of the value of petrography in estimating coke strength. Also, in combination with chemical analysis, the reflectance can be used to determine the degree of coalification and coal blend proportion. This simple technique of reflectance measurements, where applicable, is quite rapid and inexpensive, and provides a practical quality control to the coke-oven operator.

It is not intended to present a review of the developments and recent trends in the science of coal petrography. A chronological development and the present status of coal petrography has been summarized and reviewed in the articles by Harrison[1] and Marshall.[2]

The petrographic evaluation of coal by reflectance studies is based on the knowledge that coal is a heterogeneous substance composed of macerals, each of which has distinct physical properties for a specific rank of coal.

The various types of macerals composing the coal can be grouped into two major categories, namely, (i) the reactives and (ii) the non-reactives or inerts. The reactive components, which always contain most of the volatiles, are the vitrinoids, exinoids, resinoids and semi-fusinoids. Of these, the vitrinoids are present in greatest abundance in most coals. These reactives, during carbonization, pass through a fluid or plastic phase, and ultimately solidify to form the main mass of the coke cell-walls. Each type of vitrinoid material yields a carbonization product possessing a different strength. The non-reactives or inerts are comprised of fusinoids, micrinoids and mineral matter. The micrinoids and fusinoids are always low in volatiles and higher in carbon than the reactive components. They remain largely inert or unchanged during carbonization, and are incorporated by the reactives into the coke mass.

The studies of Ammosov,[3] Schapiro and Gray,[4] Harrison,[5] and Gin and Dahl[6] are based on the basic assumption that for each rank of coal, there is an optimum ratio of the reactive to inert macerals that will yield the strongest coke. Hence the petrographic work consists in determining this ratio for various ranks of coal, and devising a method of proportionately combining the data of individual coals to arrive at the weighted value for any coal blend.

The various types of vitrinoid materials are identified petrographically, by measuring the amount of vertical incident light reflected from polished surfaces. For this a Leitz Ortholux microscope is used, that is equipped with the necessary accessories for reflected light observations, and a Photovolt model 520 M photometer of which the sensing element is attached to the monocular tube of the microscope. The determination can be done quickly and with great precision and lends itself to the possibility of automating the analytical procedure. The various types of vitrinoids can be provisionally differentiated into types by assigning a reflectance range of $0 \cdot 1\%$ to each type. For example, if a vitrinoid material exhibits a reflectance of $0 \cdot 60$–$0 \cdot 69\%$ it is classed as V_6 and if a vitrinoid material exhibits a reflectance of $0 \cdot 70$–$0 \cdot 79\%$ it is classed as V_7, etc. Thus the types of vitrinoids based on reflectance values range from V_4 to V_{18} (Schapiro and Gray[4]). Low volatile coals usually contain concentrations of V_{13} up to V_{19}, while the medium volatile ones generally have concentrations of V_{10}, V_{11}, V_{12}. High volatile coals are characterized by an abundance of V_7, V_8, V_9. The reflectivity of the vitrinoid material is closely correlated to its volatile matter content.

All commercial coals contain several vitrinoid types, and each of these require an optimum amount of inert material in order to produce coke of maximum strength. Hence, it is important to know the effect of various amounts of inert on each vitrinoid type before coke strength can be calculated from coal composition. From the data provided by petrographic analyses of any coking coal sample, it is possible to calculate the strength of the coke that may be produced from it. The procedures for calculating the coke strength or stability, using the strength index and composition balance

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* Department of Geology and Geophysics, Organic Sediments Laboratory, The Pennsylvania State University.
** Coal Research Section, Geological Survey of Canada.

TABLE I

	Reactive Entities									Inert Entities					Strength index	Composition balance Index	Calculated stability
	V_4	V_5	V_6	V_7	V_8	E	R	S.F.	Total	F	M	M.M.	S.F.	Total			
Seam No. 4, (India)	0·62	6·12	11·44	5·56	1·25	22·16	0·80	5·33	53·28	23·36	8·60	4·10	10·66	46·72	0·77	3·52	0·00
Seam No. 2, (India)	1·73	13·08	25·77	11·75	1·06	18·28	1·20	2·63	75·50	10·87	4·09	4·28	5·26	24·50	1·86	1·37	0·00

ENTITY COMPOSITION VOL. PCT. — STABILITY FACTOR

COMPOSITION OF THE COALS TRIED FOR BLENDS
(Taken from Schapiro *et al.*[6])

	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	E	R	S.F.	Total	F	M	M.M.	S.F.	Total
Sewell, (M.V.) (U.S.A.)	0·00	0·00	2·80	40·80	24·8	0·70	6·00	0·10	1·20	76·40	9·80	10·20	11·30	2·30	23·60 4·41 1·07 61
Pittsburgh (H.V.) (U.S.A.)	0·70	35·90	32·40	1·40	0·0	0·00	5·90	0·90	0·80	78·00	4·10	11·90	4·30	1·70	22·00 3·66 0·72 48

Theoretically calculated stability of seams Nos. 4 and 2 with Sewell and Pittsburgh

BLENDS :
Seam No. 4 : Sewell (M. V.) ($\frac{1}{2}$: 1) .... 3·60 1·64 40
Seam No. 2 : Sewell (M. V.) ($\frac{1}{2}$: 1) .... 3·50 1·21 43
Seam No. 4 : Pittsburgh (H. V,) ($\frac{1}{2}$: 1) .... 3·10 1·20 37
Seam No. 2 : Pittsburgh (H. V.) ($\frac{1}{2}$: 1) .... 3·10 0·90 46

Abbreviation for entities : V_4-V_{13} Vitrinoids ; E—Exinoid; R—Resinoid; S.F—Semifusinoid ; F—Fusinoid; M—Micrinoid ; M.M.—Mineral Matter; M.V.—Medium Volatile; H.V—High Volatile.

index are fully described by Schapiro, Gray and Eusner.[6]

The petrography of seams Nos. 4 and 2 collected from Chirmiri colliery has been described by Babu and Dutcher,[7] in an earlier publication. The two seams were investigated in accordance with the technique previously described and with the purpose of determining their most suitable utilization.

PROCEDURE

Representative samples from seam No. 4 and seam No. 2 of Chirmiri were crushed to — 20 mesh, mixed with an epoxy resin binder, briquetted into 1 inch diameter samples, and polished to a relatively scratch-free surface. They were examined at 600 magnification using an oil immersion objective. The maximum reflectance value of 75 (scratch-free and contaminant-free) vitrinoid grains was measured and averaged. The average value is considered as the "reflectance" rank of the coal. Coal maceral determinations were made on the same pellets, and along with reflectance data are the only petrographic information required for the calculation of the optimum ratio index, the strength index and the stability. This information is presented in Table I.

The above investigations are singnificant because of the nature of these coals, which are classed as "selected grade" (11–13% ash ; and 6,800–7,000 cals./gm.) according to the coal grade classification employed in India. They explain why these high rank bituminous coals are non-coking by themselves and provide information on how a good quality coke may be obtained by their proper blending.

The reflectance studies have shown that both coals are non-coking, because they do not have the required V_9, V_{10}, etc., types of vitrinoid to induce fluidity during the coking process. Besides, the inert ratio of seam No. 4 which is calculated from the reflectance types and maceral data, exceeds the optimum ratio by 2·5 times. Seam No. 2 in this respect, is satisfactory because it has the permissible amount or inerts. However, it is suggested that the excess of

4

inerts in No. 4 seam can probably be reduced by screening and mechanical size reduction.

In Table I it is shown that it is petrographically possible to produce suitable cokes from the No. 2 and No. 4 coals by proper blending with medium volatile coals. Calculations show that a ½ to 1 blend of No. 4 or 2 coal with "Sewell" or "Pittsburgh" coal of the U.S.A. can produce a coke with a stability of 37–46. Since reflectance data along the lines described in this paper are at present not available on Indian coals, it was not possible to make calculations on blends using Indian medium volatile coals. Hence calculations were tried with some American coals, like the "Sewell" and "Pittsburgh" coals.

In conclusion it is suggested that detailed petrographic studies of Indian coals along the lines described above, and followed in the U.S.A. and U.S.S.R., may prove an invaluable criterion in evaluating the coking characteristics of the various Indian coals.

The authors thank Dr. Russell R. Dutcher of the Penn. State University for his valuable suggestions during the course of the work, and Dr. P. Hacquebard, Head of the Coal Section of the Geological Survey of Canada, for going through the manuscript and constructive criticisms.

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ANOTHER NEW PARTICLE ?

THE experimental observation on the 2π decay of the K meson reported by Fitch *et al.* of Princeton (*Physical Review Letters*, 1964, No. 13) contradicts the *CP* rule for particle reaction and has led to the postulate of a fifth natural force (see *Curr. Sci.*, 1965, 34, 133). In a recent communication to *Physics Letters* [1965, 14, (2), 131], H. J. Lipkin and A. Abashian of Illinois suggest a possible explanation for the $K \to 2\pi$ decay which does not violate the *CP* rule. The explanation assumes the existence of a new particle, another K° meson which is degenerate in mass with the ordinary K°.

The experimental observations involved are the following : According to an earlier observation of Leipuner *et al.* (*Physical Review*, 1963, 132, 2285), Decay rate $K^\circ \to 2\pi$/(Decay rate charged K° 2) $= 0.06$, for 1 GeV/c. K° at 8 ft. from target, while according to the Princeton group this branching ratio is 0.002, for 1 GeV/c. K° at 60 ft. from target. The large difference between the two decay rates is not easily interpreted if both results are due to *CP* violation or a new external field.

A natural explanation attributes the observed 2π decay to a neutral particle different from K°_1 and K°_2 and having a different lifetime from either of the two. Lipkin and Abashian estimate this lifetime as 7×10^{-9} sec., and account for the observed difference above to the exponential decay between 8 ft. and 60 ft.

An alternative assumption, the authors point out, is that this neutral particle is almost exactly degenerate with K° and anti-K°, and mixes with them in the decay process. The best test of this hypothesis seems to be further measurements of the long-lived $K \to 2\pi$ decay at different distances from the target.—[*Physics Letters*, 1965, 14 (2), 151.]

LETTERS TO THE EDITOR

A NOTE ON GODEL'S UNIVERSE

GODEL (1949) has given an interesting model of a stationary homogeneous non-isotropic universe. His line-element is

$$ds^2 = a \,[(dx^0)^2 + 2e^{x'} \,(dx^0) \,(dx^2) + \tfrac{1}{2} e^{2x'} \,(dx^2)^2 - (dx^1)^2 - (dx^3)^2].$$

a is a positive constant. (1)

The model is filled with perfect fluid of constant density and pressure given by

$$8\pi\rho = \frac{1}{2a} = 8\pi p. \tag{2}$$

The geodesics in this model have a constant twist and therefore the model is interpreted as representing a rotating universe.

We have studied perturbations of this universe when the constant density ρ is changed by adding to it a small time-dependent term. We found that if the resultant perturbed model is to be filled with perfect fluid, the perturbation in density cannot be time-dependent. As a matter of fact, we found that the perturbed universe has the same characteristics as the unperturbed one. In this way we were led to a family of Godel universes, the line-element for the family being

$$ds^2 = a[(dx^0)^2 + 2e^{x'} \,(dx^0) \,(dx^2) + \tfrac{1}{2} e^{2x'} \,(dx^2)^2 - (dx')^2 - (dx^3)^2 + 2 \left(\frac{\nu}{1-\nu}\right)^{\tfrac{1}{2}} (dx^0) \,(dx^1)], \tag{3}$$

where ν is the parameter which characterises any particular member of the family. The signature requirement of the line-element (3) restricts ν to the range $0 \leqslant \nu < \tfrac{1}{2}$. Every member of this family represents a rotating universe filled with perfect fluid, the pressure and density being given by

$$8\pi\rho = \frac{1-\nu}{1-2\nu} \cdot \frac{1}{2a} = 8\pi p. \tag{4}$$

It will be seen that Godel's universe is a member of this family corresponding to $\nu = 0$ and is the member with least density. If one perturbs the density of Godel's model and insists on the perturbed universe to be filled with perfect fluid, one gets the neighbouring member of this family.

The case when the perturbed universe is filled with fluid with non-isotropic pressure is at present being investigated.

Department of Mathematics,   H. M. RAWAL.
Gujarat University,   P. C. VAIDYA.
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EMISSION SPECTRA OF *o*-, *m*- and *p*-CHLOROBENZALDEHYDES

LIKE benzaldehyde, *o*-, *m*- and *p*-chlorobenzaldehydes have three distinct regions of electronic absorption[1,2]—the first at about 3750 Å, the second at about 2900 Å and the third at about 2500 Å. The first system arises due to $n-\pi^*$ transition whereas the other two systems arise due to $\pi-\pi^*$ transition. It was considered desirable to record the emission spectra of these isomers. In this brief paper we report the data obtained from the emission spectra of *o*-, *m*- and *p*-chlorobenzaldehydes. We have also made a detailed study of the absorption system in each of these molecules which lies at about 3750 Å. It has been found that the emission spectra observed are the counterparts of the absorption systems of the molecules on the longest wavelength side and have a good resemblance with the emission spectrum of benzaldehyde. The spectra were photographed on a Fuess glass and a Zeiss medium quartz spectrographs. The results obtained are summarised below:

o-Chlorobenzaldehyde.—The emission spectrum of this molecule lies in the region 3780–5600 Å and consists of nearly hundred bands. A weak band at 25900 cm.$^{-1}$ is identified as the O—O band. The frequency 1710 cm.$^{-1}$ is found as the most prominent frequency forming a long progression of which four members are observed at 24190, 22474, 20798, and 19091 cm.$^{-1}$ respectively. The frequency 1710 cm.$^{-1}$ corresponds to C=O stretching frequency in the ground state. This frequency and its overtones combine with other fundamentals and are involved in several other bands.

m- and p-Chlorobenzaldehydes.—The O—O bands in the emission spectra of *m*- and *p*-chlorobenzaldehydes, also observed with weak intensities, are identified at 26702 and 26808 cm.$^{-1}$ respectively. The frequencies 1718 and 1720 cm.$^{-1}$ in *m*- and *p*-chlorobenzaldehydes respectively

are found to be most prominent ones forming long progressions. These along with their overtones also combine with other fundamentals and enable interpretation of other bands.

The observed shift of the O—O band is in the order $o > m > p$ which is in agreement with the fact noticed theoretically as well as experimentally by previous workers in substituted benzaldehydes.[3,4] The various fundamental ground and excited states frequencies obtained in o-, m- and p-chlorobenzaldehydes are given below :

	Ground state frequency	Excited state frequency
o-Chlorobenzaldehyde	126, 155, 201, 244, 288, 417, 717, 760, 823, 1040, 1125, 1196, 1527, 1565, 1586, 1644, 1710, 3060	101, 166, 216, 267, 378, 437
m-Chlorobenzaldehyde	140, 172, 230, 508, 711, 803, 1011, 1204, 1386, 1626, 1718	132, 239, 707
p-Chlorobenzaldehyde	91, 188, 2123, 247, 616, 700, 789, 843, 861, 941, 1042, 1161, 1218, 1390, 1459, 1625, 1720	114, 263, 567, 650, 734, 804, 861, 1005

Department of Spectroscopy,   D. P. JUYAL.
Banaras Hindu University,
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GRAFT CO-POLYMERIZATION BY CHAIN TRANSFER

GRAFT polymerization by chain transfer is not as widely recognized as other methods of grafting—irradiation by γ- and X-rays,[1] use of photosensitizers, etc.[2] Polymerization of methyl methacrylate in the presence of chlorinated rubber (chlorinated polyisoprene) (ratio 1 : 0·32) in toluene solution with benzoyl peroxide as the catalyst at 80° C. has yielded a graft polymer with polymethylmethacrylate grafts on rubber backbone. The active centres for grafting on the backbone are formed as a result of chain transfer reaction between rubber molecule and polymethylmethacrylate radicals. The homopolymethylmethacrylate is separated from the graft co-polymer by fractional precipitation from a solution of the polymer mixture in 2-butanone by addition of methanol.

We report briefly our results :

(*i*) Grafting efficiency defined by the ratio, weight of polymethylmethacrylate in the graft co-polymer/total weight of polymethylmethacrylate in the graft- and homo-polymers has been found to decrease (0·33 to 0·12) as the catalyst concentration increased (0·068 to $5·3 \times 10^{-3}$ M).

(*ii*) Chain transfer constant, C_p, for the reaction, polymethylmethacrylate radical and rubber molecule, has been evaluated by measurements of degree of polymerization Pn, of homopolymer obtained in the presence of rubber and degree of polymerization Pn_0, in the absence of rubber, under identical circumstances. It is easy to show that

$$\frac{1}{Pn} = \frac{1}{Pn_0} + Cp \frac{[P]}{[M]}$$

where [P] and [M] refer to molar concentrations of polymer and monomer respectively. A value of $2·34 \times 10^{-3}$ for C_p has been evaluated. C_p values for polymethylmethacrylate radicals to dead polymethylmethacrylate polymer[3] and to polyvinyl chloride[4] are reported to be $0·3 \times 10^{-4}$ and $1·1 \times 10^{-3}$ respectively.

(*iii*) The proof that the co-polymer formed under our experimental conditions is really graft in nature and the determination of number of grafts per backbone molecule have been obtained by analyses of light scattering and viscosity data on backbone- and graft-polymers by the method due to Zimm.[5] We report the results in Table I.

TABLE I

Polymer	$M_w \times 10^{-6}$	$\langle S^2 \rangle \text{cm.}^2 \times 10^9$	$A_2 \times 10^4$	$[\eta]$ dl/g.
Pure backbone	4·42	1·35	−0·188	0·225
Graft co-polymer	8·16	3·0	2·45	0·265

Each backbone molecule is found to have *ca.* 30 grafts of polymethylmethacrylate or one graft for every *ca.* 700 structural units of the backbone.

We wish to emphasize, that we have described above one of the simplest methods of "grafting". Full details will appear elsewhere.

Dept. of Physical Chem.,   S. PRABHAKARA RAO.
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CHEMISTRY OF *TERMINALIA* SPECIES

Part X.* Isolation of O-Pentamethyl Flavellagic Acid from *T. paniculata* Roth.

DURING a re-examination of the heart-wood of *T. paniculata* Roth. (2 kg.), secured from Mangalore, ellagic acid, 3 : 3'-O-dimethyl ellagic acid and β-sitosterol were identified in the alcoholic extract. The 4-glucoside of 3 : 3'-O-dimethyl ether of ellagic acid[1] was not, however, noticed. The residue from the 3 : 3'-O-dimethyl ellagic acid could not be effectively fractionated through crystallisation from solvents and chromatographic separation was unsuccessful because of the sparing solubility of the residue in common solvents. The residue was, therefore, completely methylated (diazomethane). A thin layer chromatogram of the methylated residue revealed two spots. It could be separated into two fractions by means of acetone. The sparingly soluble fraction readily crystallised from dioxan-methanol and was found to be identical with O-tetramethyl ellagic acid; m.p. 340–42°. Yield 450 mg. (Found : C, 59·8 ; H, 4·01 ; OMe 33·1 ; $C_{18}H_{14}O_8$ requires C, 60·3 ; H, 3·90 ; 4-OMe 34·6%.)

The second fraction crystallised from acetone or methanol as colourless needles, m.p. 240–41°. Yield 400 mg. (Found : C, 58·69 ; H, 4·083 ; OMe, 38·54 ; $C_{19}H_{16}O_9$ requires C, 58·76 ; H, 4·12 ; 5-OMe, 39·95%.) It gave a bright yellow solution in conc. H_2SO_4 like O-tetramethyl ellagic acid. Its molecular formula suggested an extra methoxyl in the molecule and from its other reactions (Sol. in NaOH) it could be regarded as flavellagic acid pentamethyl ether. Indeed, it is identical in every respect with a synthetic sample, obtained by the method of Leonard Jurd.[2]

This isolation of flavellagic acid as its pentamethyl ether appears to be the first recorded instance of its occurrence in nature. Flavellagic acid was first obtained by Perkin[3] as a by-product in the oxidation of gallic acid with potassium persulphate in sulphuric acid medium. Its synthesis was later developed by him and improved more recently by L. Jurd.[2]

One of us (R. R. R.) wishes to express his thanks to the Council of Scientific and Industrial Research for a Fellowship.

Dept. of Chemistry,   L. RAMACHANDRA ROW.
Andhra University,   R. RAMAKRISHNAM RAJU.
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MODIFIED METHOD FOR THE SYNTHESIS OF 3-AMINO COUMARIN

DIFFERENT amino compounds containing α- and γ-pyrone rings were required as the starting material for our synthetic work. While searching in the literature it was found that 3-amino coumarin was synthesised by Pandya and Sodhi in 85% yield.[1] According to the prescribed method glycine was condensed with salicylaldehyde in presence of traces of pyridine. However on repeating their method we failed to obtain the desired product. The failure of Pandya's method led us to modify the reaction procedure. From Pandya's reaction a red gummy substance (V) was obtained every time.

Our modification consists of blocking the amino function of glycine by acetylation.[2] This acetyl glycine (I) on condensation with salicylaldehyde in presence of acetic anhydride and traces of pyridine or piperidine gave the acetyl derivative of 3-amino coumarin (III) in 45% yield. On acid hydrolysis 3-amino coumarin (IV) was obtained in satisfactory amount (40·8%).

Attempts were made to characterise the gummy product (V). While it was not possible to crystallise (V), two products were isolated from it by solvent treatment, one soluble in chloroform (VI) and the other soluble in alcohol (VII). On running paper chromatography it was found that (III) and (VI) are homogeneous with characteristic fluorescent spots of Rf—0·82 and 0·86 respectively, while (VII) gave two fluorescent spots (Rf—0·75 and 0·92). The fraction (VI) could be induced to crystallise and it was found to be the salicylidene derivative of 3-amino coumarin. Because our 3-amino coumarin on condensation with salicylaldehyde gave the same product as (VI) and it was found that the Schiff's base as formed in Pandya's reaction gave 3-amino coumarin on acid hydrolysis.

The alcohol-soluble fraction (VII) failed to crystallise and was not worked out further. In passing it may be mentioned that different 3-alkylsulphonyl coumarins were obtained when different alkylsulphonyl acetic acids were made to react with salicylaldehyde.[3] Derivatives of 3-amino coumarin were also prepared later, by Rodighiero and Antonello.[4]

EXPERIMENTAL

Synthesis of 3-Amino Coumarin.—Glycine was acetylated[2] and the acetyl glycine (10·4 g.) was mixed with salicylaldehyde (20 g.), acetic anhydride (10 g.) and pyridine (2 c.c.) and the mixture was heated at 120–25° for 28 hours. The reaction mixture was diluted with water,
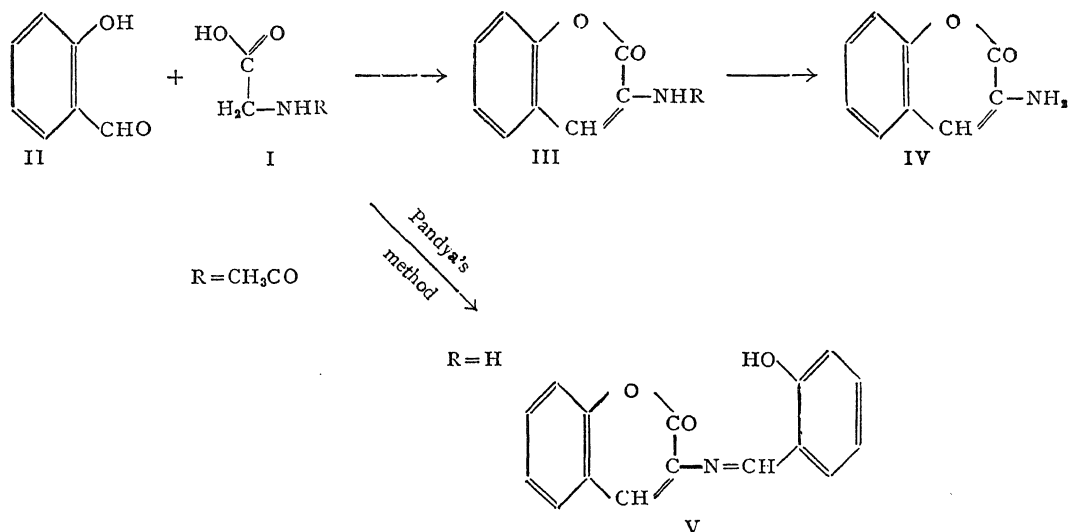
heated on a water-bath for some time and the liquids were removed under reduced pressure. The residue was dissolved in minimum volume of alcohol and kept overnight at 0° C. for crystallisation. The crystals were filtered, washed with cold aqueous alcohol, cold 1% KOH solution and then with distilled water and dried (Yield of acetyl amino coumarin 8·10 g., 45·0%).

A small portion of the acetyl amino coumarin was dissolved in chloroform and decolourised by passage through a column of charcoal and then purified by three successive recrystallisations from alcohol, m.p. 200–201° C.

The crude acetyl amino coumarin (5·0 g.) was dissolved in cold alcoholic hydrochloric acid (1 : 2 v./v.), boiled for a few minutes, cooled, diluted with water, and neutralised with cold saturated NaHCO₃ solution. The solids deposited were filtered, decolourised with animal charcoal and recystallised from dilute alcohol (Yield 3·60 g., 90%).

The product was purified further by three successive recrystallisations from dilute alcohol (m.p. 133° C ; Analysis : found C—67·50%, H—4·31%, N—8·49% ; calcd. for $C_9H_7O_2N$, C—67·08%, H—4·35%, N—8·69%). $\nu_{max.}$ (1·2% in CHCl₃): 3400 cm.⁻¹, 1650 cm.⁻¹ (NH₂), 1750 cm.⁻¹ (δ-lactone), 1630 cm.,⁻¹ (—CH = C —, Phenyl conjugated).

Paper Chromatography.—Paper chromatography was carried out in Whatman No. 1 paper by downward irrigation with the organic phase of the solvent system *n*-butanol-ethanol-water (5 : 1 : 4 v./v.). On exposure to U.V. light, the product was revealed as a distinct fluorescent (blue) spot (R_F—0·82).

Repetition of the Procedure of Pandya and Sodhi[1] and Isolation of 3-Salicylamino Coumarin. —A mixture of salicylaldehyde (3·0 g.), glycine (1·25 g.) and pyridine (0·2 c.c.) was heated in an oil-bath at 130–40° C. for five hours after which the reaction mixture was extracted with alcohol and filtered. The dark red alcoholic extract was concentrated and to the residue cold water was added when a yellow amorphous ppt. was obtained. The residue was ground with an excess of cold water to remove any adhering traces of pyridine or glycine. Attempts to crystallise this residue from alcohol were not successful, a red gummy product being obtained every time. This residue was then extracted in the soxhlet successively with chloroform and then with alcohol.

The chloroform extract was evaporated to dryness, residue dissolved in minimum volume of dry chloroform and crystallised as reddish-yellow crystals with the addition of a little alcohol. The product was further purified by four successive recrystallisations from chloroform-alcohol. From analytical data and I.R. spectra, the product appears to be the salicylidene derivative of 3-amino coumarin.

Yield.—1·0 g. ; m.p. 189–90° C. Analysis : C—72·47%, H—4·37%, N—5·45%. Calcd. for $C_{16}H_{11}O_3N$, C—72·45%, H—4·15%, N—5·28%. $\nu_{max.}$ (2·5% in CHCl₃): Stretching between 3550 cm.⁻¹ to 3420 cm.⁻¹ (OH) 1620 cm.⁻¹ (—C = N—), 1730 cm.⁻¹ (δ-lactone).

Paper Chromatography.—Paper chromatography of the product m.p. 189–90° C. using the previous technique revealed the presence of a single U.V. fluorescent (blue) spot R_F—0·86).

The alcohol extract was concentrated and cooled to 0° C. when a yellow amorphous ppt. was obtained ($1\cdot0$ gm.). Paper chromatographic examination of the ppt. revealed the presence of two. U.V. flourescent spots (R_F—$0\cdot75$ and $0\cdot92$).

Preparation of 3-Salicylidene Amino Coumarin.—(1) 3-Amino coumarin ($0\cdot5$ gm.), salicylaldehyde (1 c.c.) and pyridine (few drops) were heated in a sealed tube for 5 hours at 130–40° C. The reaction mixture was evaporated to dryness, the last traces of salicylaldehyde being removed under high vacuum, dissolved in minimum volume of chloroform and passed through a column of charcoal, the effluent ($CHCl_3$) concentrated to a small volume and kept at 0° C. with addition of a little alcohol. A reddish-yellow crystalline product was obtained which was purified by four successive recrystallisations from chloroform-alcohol (Yield 50 gm., m.p. 188–89° C.). The mixed melting point with VI remained undepressed.

Isolation of 3-Amino Coumarin from Pandya Product.—(2) Pandya's Product (300 mg.) was boiled under reflux with dilute aqueous alcohol (10 c.c.) containing conc. HCl (2 c.c.) for 2 hours, diluted with water, neutralised with aq. $NaHCO_3$ soln., filtered, the residue was dissolved in minimum volume of alcohol, passed through a column of charcoal, the effluent (alcohol) concentrated to a small volume and kept at 0° C. with the addition of a little water when flaky crystals were obtained. The product was further purified by four successive recrystallisations from alcohol–water (yield 100 mg., m.p. 131–32° C.). On admixture with authentic 3-amino coumarin, the melting point remained undepressed.

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Pure Chemistry Dept.,   D. CHAKRAVARTY.
Calcutta University ;
Dept. of Food Tech. and   S. P. DUTTA.
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CHEMICAL EXAMINATION OF FRUITS OF *CLEISTANTHUS COLLINUS* (ROXB.) BENTH. AND HOOK. F.

Cleistanthus collinus, belonging to the family Euphorbiaceæ, is a small tree distributed from the Deccan peninsula northwards up to the Ganges. The leaves, roots and fruits are poisonous and a toxic glucoside oduvin from the leaves was reported earlier.[1] The tannin contents of different parts of the plant were also determined.[2]

In course of the routine chemical screening of various plants now being undertaken in this Department, presence of sterols and triterpenoids was indicated in the petroleum ether fraction apart from tannins in the alcohol fraction of the fruits. The present study identifies the sterol and the triterpene.

1,600 gm. of powdered fruits was extracted with alcohol in a Soxhlet apparatus and the alcohol-free extract was repeatedly shaken with petroleum ether (60–80°). The crude oily mass left after evaporation of the petroleum ether was hydrolysed with 10% alcoholic caustic potash and the non-saponifiable fraction was worked up in the usual way. The non-saponifiable fraction ($4\cdot66$ gm.) was chromatographed over neutral alumina from which two compounds were separated; compound A, m.p. 183–87° came in the eluent petroleum ether : benzene (1 : 1) and compound B, m.p. 123–27° appeared in ethyl acetate.

The compound A (2 gm.) could be purified by repeated crystallisations from acetone and then methyl alcohol in needles, m.p. 208–10° (Found: C, $85\cdot09$; H, $11\cdot62$; $C_{30}H_{50}O$ requires C, $84\cdot5$; H, $11\cdot75$). It gave pink coloration with Liebermann-Burchard reagent and yellow coloration with tetranitromethane. With pyridine and benzoyl chloride it gave a benzoate which could be crystallised from chloroform and methyl alcohol in needles, m.p. 267–68° (Found : C, $83\cdot42$; H, $9\cdot687$; $C_{37}H_{55}O_2$ requires C, $83\cdot77$; H, $10\cdot19$). The product A appeared to be lupeol which was confirmed by mixed m.p. determination with an authentic sample of lupeol and also from perbenzoic acid titration.

The compound B ($2\cdot24$ gm.) was crystallised from methyl alcohol in needles, m.p. 139–40°. It gave blue coloration with Liebermann-Burchard reagent and responded to tetranitromethane. With pyridine and acetic anhydride it gave an acetate, m.p. 130–31° (Found C, $81\cdot29$; H, $10\cdot67$; $C_{31}H_{52}O_2$ requires C, $81\cdot59$; H, $11\cdot4$). The product B appeared to be β-sitosterol which was confirmed by mixed

m.p. determination of the acetate with an authentic sample of β-sitosterol acetate.

The fruits of *Cleistanthus collinus* was thus found to contain 0·125% lupeol and 0·14% β-sitosterol.

Chemistry Department,   P. C. MAITI.
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OCCURRENCE OF "GLAUCONITE" IN SOME SUB-SURFACE CORES FROM SANAND WELL NO. I, WESTERN INDIA *

GLAUCONITE occurs in cores W.L.C. 12, 13, 14, 15 and 16 in Sanand-1 well (between 23° 5′ N. and 23° 10′ N. lat. and 72° 25′ E. and 72° 30′ E. long.) drilled for oil exploration in Gujarat by the Oil and Natural Gas Commission. There are no exposures of glauconite-bearing rocks in this area and the glauconitic material extends from about 980·00 mts. to 1230·00 mts. below the surface. The lithology of this zone is dominantly shale and clay containing foraminifers, ostracodes, and shells of pelecypod and other bivalves in the lower part. Arenaceous material increases in the upper part of this zone where fossils are rare and glauconite is evenly distributed in the matrix material. The glauconite-bearing zone ranges in age from upper Eocene to the lowermost Miocene and glauconite is more abundant in the sediments belonging to the Oligocene. However, glauconite was reported earlier (unpublished) to occur in equivalent stratigraphic horizons from Cambay and Anklesvar basins. The glauconite pellets have an outer ring of iron oxide which is broken up in some cases. Elsewhere, the glauconite occurs as a filling material inside shells of pelecypod and ostracodes and some of the foraminifers. The pellets are distinguished by their form, green to brownish-green color, feeble pleochroism, and association with fossils. Optically glauconite is distinguished by its refractive index which ranges between 1·615 and 1·640 and strong birefringence. Some of the pellets give biaxial negative interference figures.

Four different types of glauconite are noted based on their mode of occurrence: (1) Dark green to brownish-green pellets, (2) Single-rimmed pellets, (3) Multiple-rimmed

pellets, (4) Filling material in fossils. In almost every case the rings are brownish in color and it is quite common to find glauconite as pellets with a green nucleus surrounded by a brown ring or a brown nucleus enclosed within a green ring.
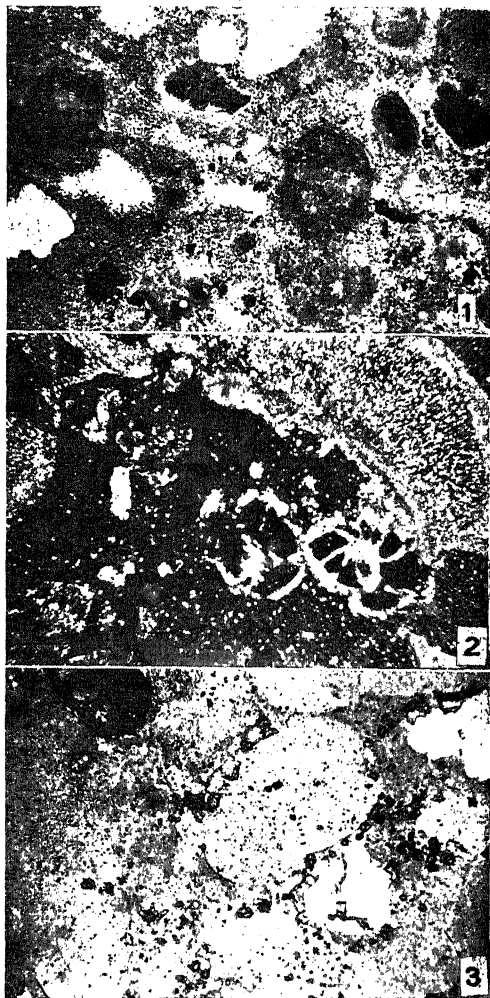
FIGS. 1–3. Fig. 1. Rimmed glauconitic pellets in clay matrix (nicols not crossed, × 30). Fig. 2. Glauconitic material filling in fossil foraminifera associated with algal material (nicols not crossed, × 30). Fig. 3. Typical glauconitic pellets with finer grains of pyrite (nicols not crossed, × 30).

The mineralogy and geochemistry of glauconite have been summarised by Burst,[1,2] Cloud,[3] Takahashi[4] and Carozzi.[5] It is possible that the glauconitic pellets without rings and those which occur as filling material in fossil shells originated *in situ* while the rimmed ones are presumably transported when their surface got oxidized and

thus developed the brown ring. However, the ring could have broken during the transportation process. It is suggested that possibly the multiple-rimmed pellets represent secondary overgrowth in different stages. The fossils associated with glauconite-bearing zone indicate a marine, shallow water, and undisturbed shelf conditions. Pyrite is very common in the filling material in some of the ostracodes. It is doubtful whether the pellets were formed penecontemporaneously with deposition or owe their origin to some sort of diagenetic processes. The factors which have contributed to the origin of glauconitic material *in situ* could be summarised as : (*i*) moderately anaerobic or reducing environment, (*ii*) slow or negative sedimentation, and (*iii*) availability of large amounts of putrefying organic material.[6]

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FOSSIL WOOD OF DIPTEROCARPACEAE FROM THE TERTIARY OF BURMA

A NEW fossil wood of Dipterocarpaceæ is recorded here from the Tertiary of Burma based on material sent to the late Professor B. Sahni by a Rangoon University botanist in 1934. As it shows the anatomical characters of the genus *Shoreoxylon* Den Berger (1923) and differs from all its known species from India (Ramanujam, 1955, 1960; Navale, 1962; Eyde, 1962) and abroad (Den Berger, 1923, 1927; Schweitzer, 1958), it is being assigned to a new species, *Shoreoxylon burmense*.

The fossil wood is represented by a small piece of decorticated secondary xylem and shows the following characters : *Wood* diffuse-porous (Fig. 1). *Growth rings* absent. *Vessels* large to medium sized, t.d. 135–240 μ, r.d. 225–360 μ, mostly solitary, often in radial multiples of 2-3 cells, 5-6 per sq. mm.; tyloses and gummy

deposits present ; vessel-members short with truncate ends : perforations simple ; intervessel pit-pairs small, alternate, bordered with linear to lenticular apertures. *Tracheids* associated with the vessels along with the paratracheal parenchyma. *Parenchyma* paratracheal and apotracheal (Fig. 1); paratracheal occurring as
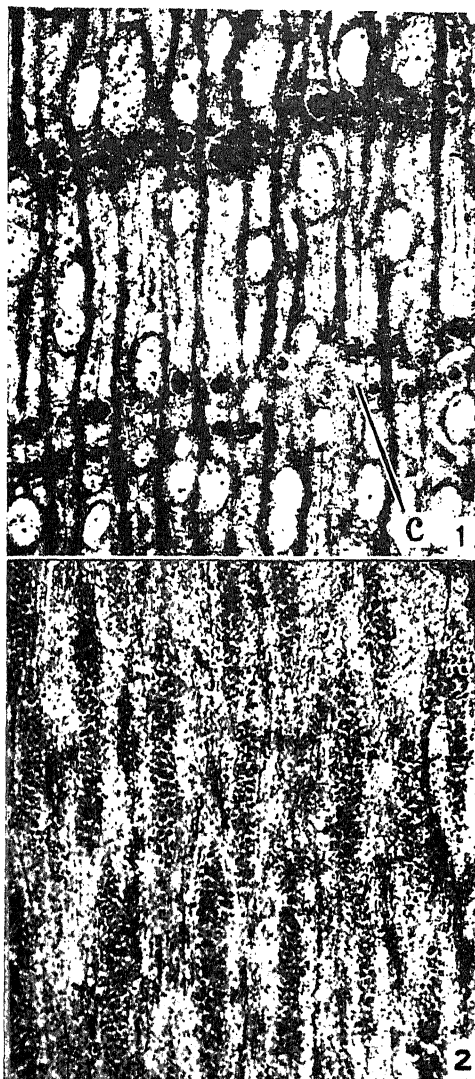
FIGS. 1-2. *Shoreoxylon burmense* sp. nov. Fig. 1. Cross-section showing the distribution of vessels and gum canals (C) in tangential rows, × 30. Fig. 2. Tangential longitudinal section showing the xylem rays, × 70.

vasicentric sheath, sometimes with a tendency to join two or more adjacent vessels ; the apotracheal type either diffuse occurring as solitary or in groups of cells or in tangential bands associated with the gum canals. *Xylem*

rays 1-5 (mostly 4-5) seriate (Fig. 2), and 12-75 μ broad, 7-10 per mm.; ray tissue homogeneous to weakly heterogeneous with rays composed mostly of procumbent cells (Fig. 2). *Fibres* libriform, very thick-walled with small lumina, non-septate, and polygonal in cross-section. *Gum canals* vertical, arranged in 1-3, rarely 4 tangential rows (Fig. 1), embedded in parenchymatous tissue, round to oval, 45-150 μ in diameter.

Birbal Sahni Institute of   U. PRAKASH.
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PALMOCARPON LESQUEREUX AND ITS SYNONYMY WITH *PALMOCARPON* MIQUEL

IN the literature on fossil palm fruits one comes across two names, *viz.*, *Palmocarpon* Miquel and *Palmocarpon* Lesquereux.[2] Miquel instituted the genus *Palmocarpon* in 1853 for some palm fruits from the Upper Cretaceous of Limburg in Belgium and defined it as *"Fructus ellipsoideus trigonus utrinque acutus, centro tumidus, pericarpio crasso?, extus longitrose tenuiter striulato, angulis versus basis et apicem acutatis sulcatisque".*

Perhaps unaware of this prior use of the generic name *Palmocarpon* by Miquel, Lesquereux also instituted the genus *Palmocarpon* in 1878 for some palm fruits from the Tertiary of New Mexico. The definition of his genus *Palmocarpon* reads as *"Fruits of various sizes and forms, generally surrounded by a shelly pericarp, and found in connection with remains of palms".*

The two homonyms are also synonyms. The only difference between the two is that the latter is from the Tertiary while the former belongs to Upper Cretaceous. This is an insufficient reason for maintaining both the homonyms and is also against the *International Rules of Botanical Nomenclature.*[3] The latter homonym, *Palmocarpon* Lesquereux, should therefore be rejected in favour of *Palmocarpon* Miquel which obviously has priority.

Birbal Sahni Institute of   R. DAYAL.
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NOTE ON A NEW SPECIES OF FOSSIL FROG FROM THE INTERTRAPPEAN BEDS OF MALABAR HILL, BOMBAY*

A NEW species of fossil frog, *Indobatrachus malabaricus,* has been collected by the author from the Intertrappean Beds exposed at the foot of the Malabar Hill, west of Chowpatty Bunder, Bombay. These fossils occur in dark grey to bluish-grey argillaceous rock with very thin black shaly partings and have been found to be associated with ribbed fragments of plants and large pieces of carbonised matter.

The fossil frogs have been known to occur in the Intertrappean Beds of Bombay for a long time but they were described first by Owen (1847) as *Rana pusilla.* Later Wynne (1869), Stoliczka (1869), Ribeiro (1921), Noble (1930) and Chiplonker (1941) recorded their occurrence from the same beds of Bombay. Noble (*op. cit.*) created a new genus, *Indobatrachus,* for all the fossil frogs of Bombay Intertrappeans.

A brief diagnosis of the present species is given below: Head large, anteriorly rounded off, broader than long; teeth on maxillaries, premaxillaries and vomers; nasal and parietal present; fronto-parietal separated by a broad median fontanel; ethmoid broad; squamosal small; vertebral column with nine pro-cœlus vertebræ having well-developed zygopophyses; sacral vertebra with dialated diapophyses and followed by a slender bony rod, coccygeal style; vertebral column two and half times longer than coccygeal style; terminal phalanges long and tapering; humerus almost as long as suprascapula; radius and ulna fused; tibia and fibula fused; femur always a little longer than the tibio-fibula; head of the femur like a ball; pelvis less than half of the length of the vertebral column.

The most striking feature of the present species is that its vertebral column is always more than twice the length of the pelvis. Ratio of the length of the vertebral column to that of the pelvis is 213-18/100 while it is 181-83/100 and 153/100 in *Indobatrachus trivialis* Chipl. and *I. pusillus* (Owen), respectively. The other

major difference is that while in the present species the femur is always a little longer than tibio-fibula, it is either equal to or a little less than the latter in the other two species. The other differences are in the ratios of length of the head to its width and the length of the hind limb to the length of the body. The former ratios are 81–82/100, 94–95/100 and 97/100, and the latter ratios are 147·75/100, 134–36/100 and 135–38/100 in the present species, *I. trivialis* Chipl., and *I. pusillus* (Owen), respectively. These differences in the three species of fossil frog mentioned above do not appear to be due to the different growth stages of a single species.

In view of the above considerations the present species appears to be entirely different from the earlier described ones, hence a new name, *Indobatrachus malabaricus,* is proposed. The specific name is after the locality of its occurrence, the Malabar Hill, Bombay.

The author expresses his thanks to Shri V. R. Khedkar, Director, G.S.I., and to Dr. A. P. Subramanyam, Superintending Geologist, G.S.I., for their interest in the present work ; and to Shri Promod Darbari of A.E.E., Trombay, Bombay, for his untiring help in the field. The author records with deep regret the unfortunate death of Shri Darbari in a laboratory accident at A.E.E., Bombay.

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OCCURRENCE OF ANTIGENIC VARIATION IN *BORELLIA GALLINARUM* SPECIES

Literature on the antigenic variations among *Borellia gallinarum* is very scarce. We prepared two small batches of formalised egg-grown fowl spirochætosis vaccine using an imported Australian strain. The batches were subjected to necessary sterility, safety and potency tests. Four fowls were injected each with 3·0 ml. and 8 fowls each with 1·0 ml. of the vaccine intramuscularly. Three weeks after vaccination the fowls were divided into two comparable groups and along with controls were challenged with fresh Australian and an Indian field strain of *Borellia gallinarum.* The challenge dose was fixed at 0·5 ml. of the infected fowl blood showing teeming Spirochætes of Australian as well of the Indian strain. In case of Australian strain it was worked out that the challenge dose consisted of at least 100 m.i.d.s.

Our observations are summarised as follows :

(*a*) The vaccine was non-toxic and did not produce any shock even at 3 field doses when inoculated intramuscularly in healthy cockerels of 12 weeks of age.

(*b*) The vaccine afforded solid immunity against Australian strain of organisms.

(*c*) When the vaccinated fowls were challenged with the Indian strain of organisms, there occurred a breakdown of immunity in 3·0 ml. and 1·0 ml. dose vaccinated groups. Therefore there seems to be a certain degree of aberrant variation in the antigenic make-up of the two strains of organisms under study. This observation has been noted in both the sets of experiments. The percentage of breakdown ranged from 40% to 60%. This observation has therefore a direct bearing on any programme for production of vaccine.

Conversely we prepared a small batch of formalised egg-grown fowl spirochætosis vaccine using the Indian field strain of fowl Spirochætes and after the completion of the necessary safety, sterility tests, the batch of vaccine was subjected to potency test. Six fowls of 12 weeks of age were injected each with 3·0 ml. and 10 fowls each with 1·0 ml. of the vaccine intramuscularly. Three weeks after vaccination the fowls were divided into two comparable groups and along with necessary controls were challenged with Australian and Indian strain of *Borellia gallinarum.* The Challenge dose for Australian strain was fixed at 0·5 ml. of the infected fowl blood and for the Indian strain an arbitrarily fixed dose of 1·0 ml. to contain 100 m.i.d.s was employed as the multiplication of the organisms in healthy susceptible fowls was rather erratic.

Our observations are summarised as follows :

(*a*) The vaccine was non-toxic and did not produce any shock even at 3 field doses.

(*b*) In case of the groups challenged with Australian strain of Spirochætes a complete breakdown in immunity was noted in 1·0 ml. vaccinated lot. In the case of 3·0 ml. vaccinated

group one fowl out of three reacted showing Spirochætes in the peripheral blood. The remaining two growls remained normal. All the controls in this group reacted showing teeming Spirochætes in the peripheral blood circulation.

(c) In the case of fowls challenged with the Indian strain of organism, breakdown of immunity was noticed in one out of the five fowls in 1·0 ml. vaccinated lot, whereas all the fowls in 3·0 ml. vaccinated lot did not react and remained solidly immune to challenge. In this group, two out of the three control fowls reacted satisfactorily.

The above finding therefore stresses the need to carry out an intensive research to find out the occurrence of different antigenic strains of Spirochætes and the possibility of selecting highly antigenic strains to put up a polyvalent vaccine incorporating more than one strain of organism has to be explored.

We are thankful to Dr. J. C. Keast, Veterinary Research Station, Glenfield, Australia, for the Australian strain of Spirochætes and to the F.A.O. and to Capt. S. B. V. Rao (Poultry Pathology), IVRI, Izatnagar, for supplying the India strain of Spirochætes. We are also indebted to Shri C. Seetharaman, Head of Division, Biological Products, for his keen interest and facilities provided during the course of the work.

Biological Products
Division, Indian Veterinary
Research Institute,
Izatnagar (U.P.), 1963.

B. M. Thakral.
M. Natarajan.
A. K. Sen.*

* Present address : Bacteriology and Virology Division, Indian Veterinary Research Institute, Mukteswar—Kumaon (U.P.).

HISTOCHEMICAL STUDIES ON THE DISTRIBUTION OF ALKALINE PHOSPHATASE AMONG THE CONSTITUENTS OF THE COMPOUND EYE OF *POLISTES HARABEUS* (HYMENOPTERA)

There is hardly any evidence in the literature concerning distribution of enzymes in the various constituents of compound eyes of insects, particularly of the order Hymenoptera. Consequently it has been considered desirable to make a detailed histochemical investigation of the distribution of various enzymes among the constituents of the compound eye.

The setæ projecting from the cornea gave a negative reaction for the enzyme. This was natural since they are composed of dead material (Fig. 1, arrow S). The cornea constituting a single layer of bioconvex cells was intensely positive for the enzyme (Fig. 2, arrow CR). The corneagenous cells occupying the subcorneal area have given a positive reaction at their borders (Fig. 2, arrow CG). It is inte-
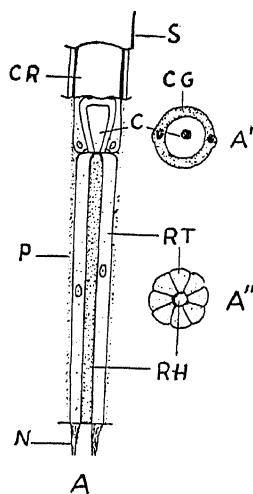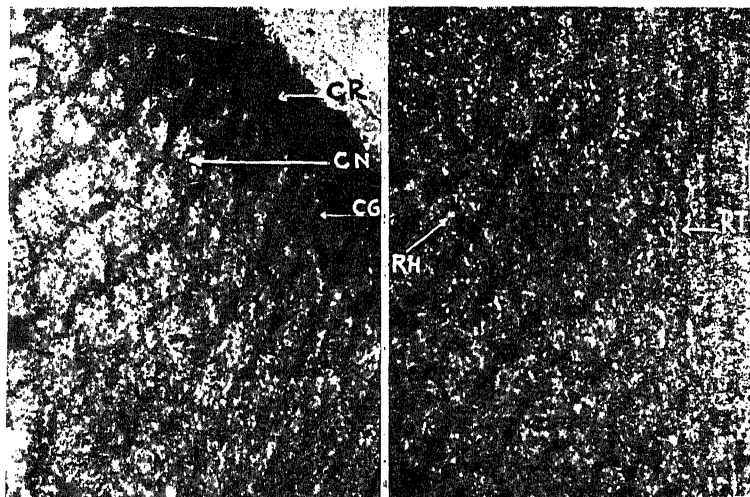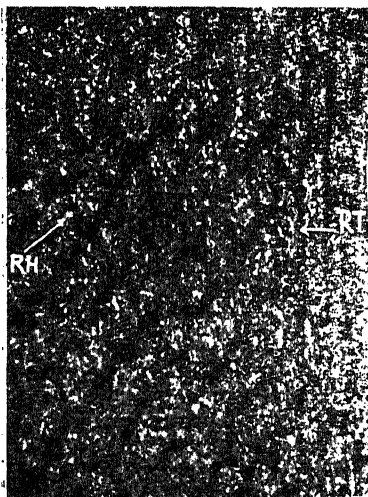
FIG. 1   FIG. 2   FIG. 3

FIGS. 1–3. Fig. 1. A—A modified diagrammatic lengthwise section of an ommatidium adapted from Snodgrass (1956) ; A′—Cross-section of the ommatidium through the crystalline cone ; A″—Cross-section of the ommatidium through rhabdome. Fig. 2. Photomicrograph of a horizontal section of the eye through cornea, × 300. Fig. 3. Photomicrograph of a horizontal section of the eye through retinular cells, × 300. C—Crystalline cone ; CG—Corneagenous cells ; CN—Cone cells ; CR—Cornea ; N—Nerve ; F—Pigment ; RH—Rhabdome ; RT—Retinula cells.

resting to mention here that these cells are densely pigmented (Snodgrass, 1935) and the location of the enzyme only at the border acquires a special significance in this context.

The cone cells, sometimes referred to as specialized corneagenous cells, are devoid of any pigment whatsoever. In these cells the enzymatic activity was seen throughout the cytoplasm (Fig. 2, arrow CN).

The retinula cells are cylindrical in outline; they encircle the rhabdome (Fig. 1 A", arrow RT). The rhabdome is completely negative for this enzyme (Fig. 3, arrow RH). The retinula cells encircling the rhabdome gave positive reaction in their nuclei.

It is difficult to pinpoint at this stage the physiological significance of the distribution of alkaline phosphatase among the constituents of the compound eye of insects. Further work is in progress regarding the distribution of alkaline phosphatase and other enzymes in relation to the cytoplasmic organalles like Golgi bodies and Mitochondria and then only it will be possible to present a correlated histochemical picture of the compound eye in relation to the functioning of its various constituents.

This work has been carried out under the guidance of Dr. H. B. Tewari to whom the author is grateful for his constant help and encouragement.

Department of Zoology,   R. P. SRIVASTAVA.
University of Udaipur,
Udaipur, *December* 21, 1964.

A NOTE ON THE EMBRYOLOGY OF GLIRICIDIA SEPIUM (JACQ) STEUD.

Gliricidia sepium (*Gliricidia maculata* Steud.), a much branched tree with dense racemes of purple flowers, is of considerable importance as a green manure plant in India and as a shade-giving plant in cocoa and coffee plantations of the West Indies and Central America. There is no information on its embryology and hence the present report.

The mature anther consists of three or four wall layers, the innermost of which forms the secretory type of tapetum. The endothecium develops the characteristic fibrous thickenings. Division of the microspore mother cells is simultaneous and cytokinesis takes place by furrowing. The pollen grains at the time of shedding are smooth-walled, triporate and binucleate.

The ovules are campylotropous, bitegmic and crassinucellate. The micropyle is zig-zag and formed by both the integuments. The archesporium which is hypodermal, consists of three or four cells. Normally only one of them is functional. Occasionally, however, two of them develop further and lead to the formation of two embryosacs in an ovule (Fig. 1). Usually a single linear tetrad of megaspores is developed in the ovule. The development of the embryosac conforms to the Polygonum type (Fig. 2). The antipodals degenerate quite early. The synergids are hooked. The polar nuclei fuse near about the egg prior to fertilisation.
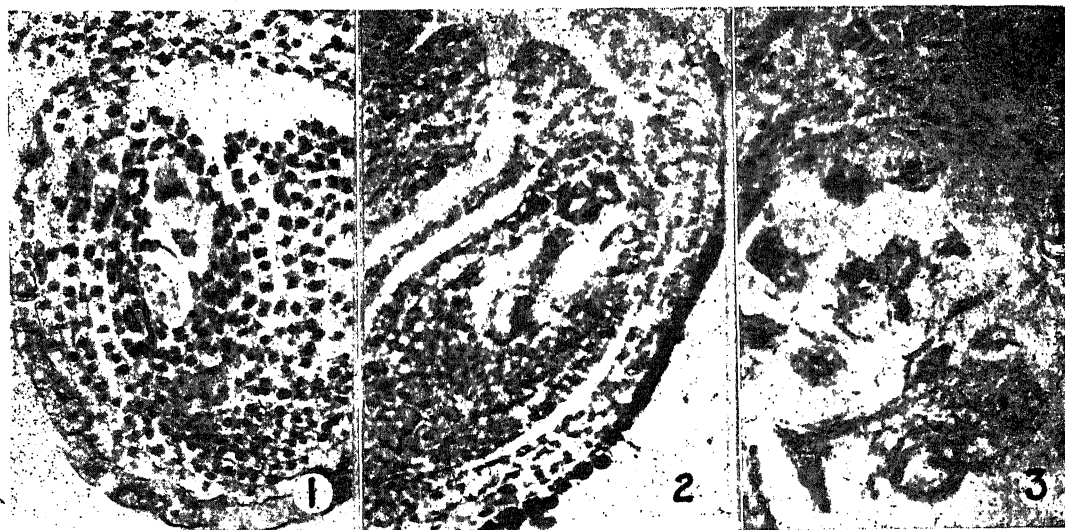
FIGS. 1–3. Photomicrographs showing (1) Two embryosacs in an ovule, × 200 *ca.*; (2) A mature embryosac, × 115 *ca*; and (3) Endosperm nodules at the micropylar region of the embryosac together with a young embryo, × 175 *ca.*

Fertilisation is porogamous. Although six to eight ovules are present in each ovary initially, only about two to four eventually develop into seeds and the rest of them degenerate.

The development of the endosperm is of the nuclear type. An interesting feature observed is that occasionally a few nuclei aggregate at the micropylar region of the embryosac and come to be surrounded by cytoplasmic vesicles in the earlier stages of the embryo development and form endosperm nodules (Fig. 3).

The development of the embryo follows the Onagrad type of Johansen[1] and keys out to the Trifolium variation and the same is schematically shown below :
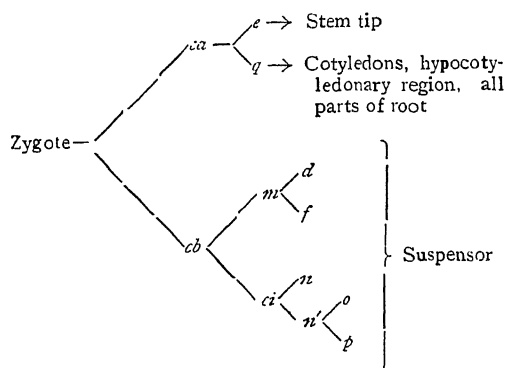
The author is thankful to Prof. J. Venkateswarlu for guidance and helpful advice and to the Government of India for the award of a Research Training Scholarship.

Dept. of Botany,   (Miss) P. Chandravadana.
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EFFECT OF GIBBERELLIC ACID ON ENDOGENOUS AUXINS IN PLANTS

Some workers have suggested that gibberellic acid (GA) might act by means of auxin sparing mechanism, since it is reported to decrease the activities of certain auxin-destroying systems in plants and to increase the level of native auxins.[1-4] According to Brian[5] the possible mechanisms of auxin mediated by GA are as follows : (*i*) GA may protect native or exogenous auxins from inactivation in the tissues ; (*ii*) it may act by increasing the synthesis of native auxin or its translocation in binding to active sites ; (*iii*) it may increase the number of sites available with which auxin molecules can react to promote growth. It has also been stated that both auxins and GA are required for cell growth.[6] Hayashi and Murakami[7] found no effect on auxin levels in pea, tomato and cucumber due to GA, while some opined strongly against any auxin-protecting mechanism by GA.[8,9]

In order to examine the action of GA on the endogenous levels of auxin in some tree species, the present study was undertaken and the results are reported here.

Seeds of *Peltophorum ferrugineum* Benth. and *Enterolobium saman* Prain. with uniform age and weight, and free from any blemish, were selected and soaked in aqueous preparations of GA (Potassium Gibberellate 10%) at 100 p.p.m. for 48 hr. The soaked seeds were sown in 12-inch earthen pots filled with washed river sand. The germinated seeds were grown subsequently in complete darkness. At two-day intervals, representative 5 gm. samples of the seedlings were collected for chromatographic analysis. The methods of extraction and chromatographic differentiations to detect the auxins were the same as described by Wright.[10] To test for biological activity of the endogenous auxins obtained in the ascending paper chromatograms, the split hypocotyl test of black gram was adopted.[11] Untreated check plants were examined similarly for comparison.

All the spots in the ascending chromatograms resembled indole acetic acid (IAA) in chromogenic characters, though there were slight variations in their Rf values. In *P. ferrugineum* the endogenous auxin content seemed to increase until the seedlings were six days old, and with the advancement of age the auxin level gradually decreased. The same trend was also noticed in the case of *E. saman*. The endogenous auxin (IAA) was detected up to 14 days in *P. ferrugineum* and up to 10 days in *E. saman*. In the check seedlings there was no development of spots in the chromatograms and in the bioassays the curvature reaction was negative.

Another set of experiment was carried out with the seedlings of the above two plant species by spraying 25 p.p.m. of GA. After spraying, the seedlings were assayed chromatographically at two-day intervals.

The chromatograms showed the presence of endogenous auxin similar to IAA, and the concentration increased due to GA spray, the maximum being found soon after the spray. The biological activity of the extract decreased with the seedling age. The chromatograms

showed that the colour development both in U.V. and day lights were similar to IAA, except slight variations in their Rf values. The chromatograms of the untreated check seedlings did not develop a coloured spot or produce the curvature in the bio-assay.

The results of the present investigations support the view that GA increases the endogenous auxin (IAA) leves of the plant tissues.

The author is thankful to Dr. G. Rangaswami, under whose guidance the work was carried out.

Faculty of Agriculture,   K. G. SHANMUGAVELU.*
Annamalai University,
Annamalainagar, *October* 31, 1964.

* Present address :   Agricultural College and Research Institute, Coimbatore 3.

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QUADRIPARTITE NATURE OF CHROMOSOME AT SOME MEIOTIC STAGES OF *ALOE VERA* L.

THE general belief is that the mitotic anaphase chromosomes are bi- or quadripartites[1-3] at the light microscope level. The recent discussion[4-7] of the utility of simple techniques for revealing the structure of chromosomes confirms the older ideas. It was possible recently to study the quadripartite nature of the meiotic chromosomes of *Aloe vera* at some stages by 'simple' techniques.

Floral buds of a horticultural variety of *Aloe vera* were fixed in 1 : 3 acetic acid (glacial): ethyl alcohol (absolute) and kept for about 48 hours (unintentionally) at room temperature during October-November. Squashes of the PMC's were made in 1% aceto-carmine and the slides were made permanent by passing through grades of butyl alcohol (in acetic acid) and mounting in Canada balsam. In these prepara-

tions the chromosomes appeared as 'solid threads' till pachytene. From diplotene onwards small colourless spaces began to appear along the length of each chromosome. These were the spaces where the chromatids had fallen apart. Similar but smaller spaces appeared along the length of each individual chromatid from anaphase I. The sister chromatids were distinctly separate in some anaphase I chromosomes and were lying parallel. The region of the metaphase II chromatid marked with arrow in Fig. 1 shows an exceptional loosening
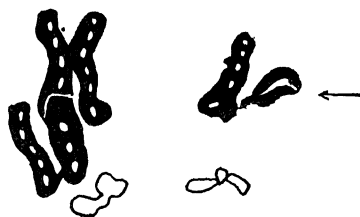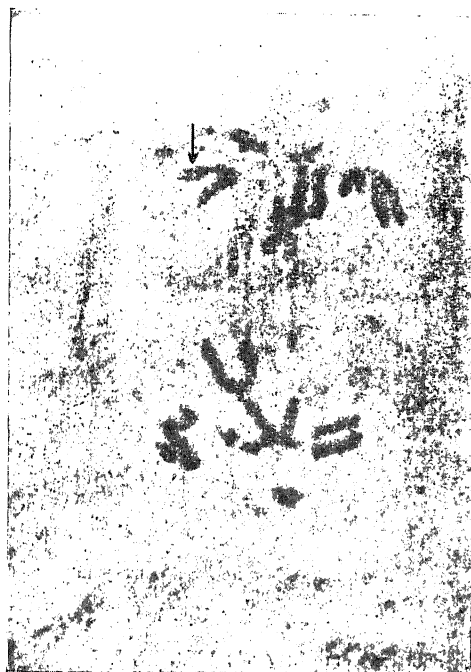
FIG. 1.   The camera lucida drawing of a part of one of the groups shows the spaces which appear along the length of the chromatids due to loosening of the chromonema at late meiotic stages. These spaces could not be obtained in the photomicrograph. Note the loosening chromonemata at the end of a chromatid ($\rightarrow$).

of the chromonemata, thus clearly revealing the bi-partite structure of a chromatid. Each of these chromonematids is superposable on the corresponding daughter chromosome of anaphase II.

The metaphase II chromosome thus has 2 chromonemata in each of its chromatids and is hence quadripartite.

During early prophase the chromonemata do not appear separate because of their tight coiling together. At later stages, however, they loosen and as a result reveal spaces ; which some workers[5] interpret as 'bubbles'. The fact that they do not appear before diplotene confirms that these are spaces and not 'bubbles'. N.HCl fixation (15 mts. at 60° C.) and boiling water fixation were also tried. In both cases the results were parallel to the above, but not as clear as with acetic-alcohol fixation. Subramaniam and Subramanyam's report about the appearance of a pellicle could not be confirmed with these meiotic chromosomes fixed in boiling water.

Modifications of technique are necessary to reveal the chromonemata in different types of material or tissues. It should be possible to reveal a quadripartite structure by simple methods at least in the large chromosomes.

I am thankful to Dean Mrs. K. Rathore and Dr. H. N. Mehrotra, Head of the Department. for facilities.

College of Agriculture,   B. K. Vig.
Udaipur, India, *October 7, 1964.*

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RESPONSE OF PADDY VARIETIES TO BLUE-GREEN ALGAE AND METHODS OF PROPAGATION

The beneficial role of blue-green algae in combination with lime, superphosphate and sodium molybdate has already been reported in earlier communications.[1-6] The object of the present investigation was to study varietal interactions to application of blue-green algae as well as response to whole seedlings *versus* clonal propagated seedlings.

An experiment was conducted in the main season of 1963, with four replicates in a split-plot design of layout consisting of four varieties of the same medium duration group, *T. 141, GEB. 24, FR. 43-B* and *J × I-431* ; two methods of propagation [seed and tiller (vegetatively) propagated]; and with and without blue-green algae (mixture of species consisting of *Anabœna* sp., *Nostoc* spp., *Tolypothrix* sp., *Scytonema* sp., and *Westiella* sp.). Main plot, variety × propagation method were split into algæ and no-algæ sub-plot treatments.

The net size of the sub-plot was 7·56 sq.m. The vegetatively propagated seedlings were raised by splitting and planting for five times within the season before final planting along with normally raised seedlings from seeds, on the 30th August. During the process of repeated planting of the split tillers, plant mortality in *GEB. 24* was found to be the least and maximum in *FR. 43-B*.

A basal application of 500 kg. lime, 20 kg. P_2O_5 and 0·28 kg. sodium molybdate per hectare was applied to all the plots before transplanting. The algal mixture was shaken and diluted with water in a plastic bucket and uniformly sprinkled on to the plots after transplanting.

The stand of the crop of *FR. 43-B* in experimental plots was poor in both the methods of propagation. In the other varieties also, a few seedlings could not establish themselves and, therefore, the yields were adjusted for unequal plant stand by the analysis of covariance. Statistical analysis for both actual and adjusted plot yield lead to the same conclusions. The yields of paddy grain in kg./ha. are given in Table I.

TABLE I

Yield of paddy grain in kg. per hectare

Variety	Treatment	Seed crop	V.P. Crop	Mean	Increase %
T. 141 ..	No algæ	3446	2729	5037	
	Algæ	3995	2911	3453	11·8*
G.E.B. 24 ..	No algæ	2566	3710	3138	
	Algæ	2906	4300	3603	14·8
F R. 43 B ..	No algæ	1073	1328	1200	
	Algæ	1331	1410	1370	14·2
Jx1431— ..	No algæ	3263	2586	2925	
	algæ	3701	2996	3349	14·5

C.D. (0·05) to compare any two varieties for a particular method of planting (Seed or V.P. cop)—539·4 Kg /ha.

* Per cent. increase by blue-green algæ.

It will be observed that under late August conditions of transplanting (1) an average significant response of 13·8% to application of blue-green algæ is obtained ; the interaction, algæ × variety, and methods of propagation were not found to be significant, (2) variety

GEB. 24 produced the highest yield and is statistically at par with varieties T. 141 and J × I-431 and variety FR. 43—B is the poorest; and (3) variety × method of propagation interaction is found to be significant.

Variety GEB. 24 proved to be the best for vegetative propagation under late planting conditions. It produced an increase of 46·4% over seed propagated crop. Variety FR. 43—B also produced an increase of 13·9% by vegetative propagation method. Varieties T. 141 and J × I-431 performed better by seed propagation under similar conditions.

The author thanks Dr. R. H. Richharia, Director, for suggesting this problem; Dr. R. Subrahmanyan for supplying algal inoculum and guidance during the course of the investigation. Thanks are also due to Shri V. J. Shrikhande and Shri G. B. Manna for statistical analysis and processing of the data.

Division of Blue–Green Algæ,   L. L. RELWANI.*
Central Rice Research Institute,
Cuttack (Orissa), *November 16, 1964.*

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INHERITANCE OF CERTAIN CHARACTERS IN RICE

THE inheritance of brittleness of the different plant parts in a rice variety, Kama-Irazu, was first studied by Jones.[3] The author obtained seed sample of a variety, CI. 7392 from Mr. N. E. Jodon, Breeder, Rice Experiment Station,

Crowley, Louisiana, U.S.A., in which the different plant parts were found to break up and crumble under strain when the plants have past the late flowering stage although this snapping of stem, leaf-blade and panicle is not prominent in the early stages. This variety resembles Koshi-ore described by Uchida cited by Nagai.[5] The sheathed ear character (enclosed panicle) of this variety (CI. 7392) resembles the enclosed earhead of Sathi variety of Uttar Pradesh, described by Sethi et al.,[8] and is slightly different from the muffled panicle described by Nagai[5] in which only the basal portion of the panicle is muffled by the upper portion of the sheath.

CI. 7392 was crossed to Ptb. 10, a cosmopolitan variety from Kerala. The contrasting characters of the parents, and the character expression in the F_1, F_2 and F_3 generations are given in Table I.

Non-brittle character, exserted panicle type, red kernel colour and awning tendency thus exhibit dominance in the F_1 generation and the segregation in F_2 corresponds to a simple 3 : 1 ratio for each pair of characters and this is again confirmed by the F_3 behaviour.

It may be concluded that brittleness of the plant parts, sheathed ear type, white kernel colour and awnless condition are each controlled by one pair of recessive genes.

A ratio of 3 normal : 1 brittle has been reported by Jones,[3] Morinaga and Fukushima.[4] Jodon,[2] Nagao[6] and Hsieh.[1] Monogenic ratio for the other characters has been reported by several workers as cited by Ramiah and Rao[7] and Nagai.[5]

The joint segregation was worked out and this showed that the recessive gene for the expression of brittle character segregated independently of genes controlling sheathed ear type, white kernel colour and awnless condition. Further, the gene controlling sheathed

TABLE I
Character expression in parents, F_1, F_2 and F_3

Character Parents and Generation	Brittleness	Nature of panicle	Colour of kernel	Awning
Ptb. 10 ..	Normal	Exserted	Red	Awnless
CI. 7392 ..	Brittle	Sheathed ear	White	Awned
Ptb. 10 × CI. 7392 (F₁)	Normal	Exserted	Red	Awned
(F₂)	95 Normal* : 23 Brittle	84 Normal* : 34 Sheathed ear	96 Red* : 22 White	93 Awned* : 25 Awnless
(F₃)	15 (Normal) †6 Pure 9 Segregating	15 (Normal) †4 Pure 11 Segregating	15 (Red) †8 Pure 7 Segregating	12 (Awned) †2 Pure 10 Segregating

* X² test significant for 3 : 1 ratio.   † X² test significant (Expected 5 :10)

ear type segregated independently of genes controlling white kernel colour and awnless condition.

The author is thankful to Dr. R. H. Richharia, Director, Central Rice Research Institute, Cuttack, where the investigation was carried out and to Mr. Nelson E. Jodon for providing the material.

Punjab Agricultural Univ.,   R. SEETHARAMAN.
Regional Rice Research Station,
Kapurthala, *October 26, 1964.*

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A NEW CHROMOSOME RACE IN *HETEROPOGON CONTORTUS*

Heteropogon contortus Roem and Schult, a member of the tribe Andropogoneæ of the family Gramineæ, is well represented in the tropics and sub-tropics of both the new and old world flora. It is used commonly as a fodder plant. Chromosome races in this species are known to occur as $n = 10$,[1] $n = 20$,[2] $n = 22$ [3] and $n = 30$[4]. Besides these, variable chromosome numbers are also reported[5] in this species. During the course of present investigation in the Gangetic plains of Bihar and U.P. (India), a new chromosome race $n = 25$ was found. This race is not very common and so far only few plants have been collected.

Polymorphism in *H. contortus* is quite conspicuous but the variations at the different ploidy levels or of the chromosome races have not been studied. Hence an effort is made to present in Table I the morphological characteristics of the new race ($n = 25$).

Cytologically these plants were very irregular during the meiotic division consisting principally of univalents and multivalents at diakinesis and metaphase I; bridges, fragments, and lagging chromosomes at anaphase; and micronuclei at the diad and tetrad spore stage.

TABLE I

Morphological characters of an intraspecific race
($n = 25$) in H. contortus

Characters studied		Observations
Growth habit	..	Decumbent
Flowering period	..	October-February/March
Culm length	..	200–500 mm (400 mm.)*
Leaf length	..	30–100 mm. (61 mm.)
Leaf breadth	..	2·5–5·5 mm. (3·9 mm.)
Epidermal cells (length)	..	60·5–95·6 (82·3 μ)
,, (breadth)		15·4–32·4 (23·5 μ)
Stomatal breadth	..	21·8–46·3 (30·6 μ)
Spike length (with awn)	..	90–120 mm.
Awn length	..	67–91 mm. (79 mm.)
No. heterogamous pairs-spike		7–10 (9·1)
No. homogamous pairs-spike		1–8 (4·3)
Total No. of spikelets-spike		11–17 (13·4)
Length-breadth of lower glume of sessile spikelet		6·5/1·5 to 8·2/1·9 (7·5/1·7)
Pollen grain (diameter)	..	32·9–39·95 (36·66 μ)
Seed weight	..	81·5 mg. (1·63 mg.) (50 seeds) (per seed)

* Average values within parenthesis.

Morphologically the tetraploid plants differ conspicuously from the pentaploid race. However, the differences between the latter and the hexaploid race were very little except for some minor details. This could explain one of the difficulties in their ($n = 25$) proper identification and collections. An assumption is made for the hybrid origin of the pentaploid race from the possible crosses between the tetraploid and hexaploid races. Thus once such plants are produced and obtain selective advantage, they are able to perpetuate in nature with the help of apomixis which is quite prevalent in this species.

A detailed comparative morphological study of the different chromosome races in *H. contortus* is in progress and shall be reported later.

Botany Department,   R. P. ROY.
Patna University,   A. P. SINGH.
Patna-5, *December 22, 1964.*   P. K. GUPTA.

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HYSTERIUM INDICUM SP. NOV. FROM INDIA

In the course of his survey for ascomycetous fungi the writer collected dead twigs of *Galphimia glauca* Cav. (Family—Malpighiaceæ) at the University campus, Poona (India), showing numerous carbonaceous elongated fruiting bodies with a central whitish slit characteristic of the family Phacediaceæ. Sections through these bodies revealed the presence of stromatic, cup-shaped apothecia with parallel asci intermingled with numerous bifurcated paraphyses forming a thin epithecial covering above. On the basis of structure and ascospore characters the fungus was determined as a species of *Hysterium* Tode, ex Fries. Although according to Saccardo a little over 100 species of this interesting apothecial genus have been described from all over the world since it was first established by Tode (1790), only one record of this genus is known from India (Tilak, 1963). A doubtful species, *Hysterium foliicolum* Fr. was collected from the Nilgiris (S. India), which has, since, been placed as a synonym of *Lophodermium hystereoides* (Pers.) Sacc. (Vasudeva, 1960, p. 74).

This interesting but rare fungus has been represented by a single species on *Janusia argentea* Griseb., of the family Malpighiaceæ, viz., *Hysterium januseœ* Rehm. (Saccardo, 1902). A critical comparison was, therefore, made between the writer's collection which is also made on a new host belonging to this host family and *Hysterium januseœ* Rehm. with the results shown in Table I.

unreported host and is, therefore, offered as a new species with Latin diagnosis as follows:

Hysterium indicum SESHADRI SPEC. NOV.

Stromata carbonacea, dispersa, erumpentia, elongata ornata scissura longitudinali (1–2 mm.),
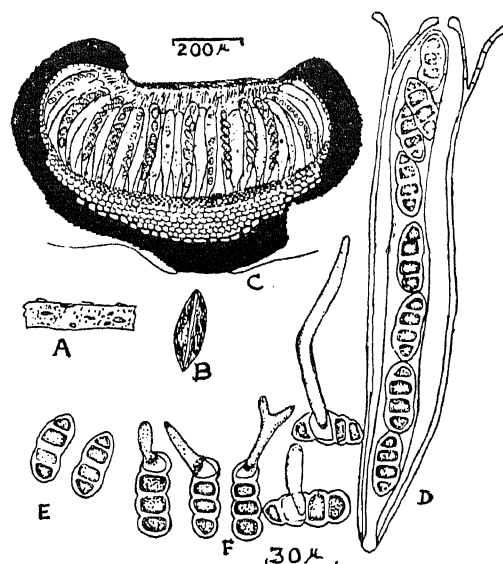
FIG. 1   A. Habit.   B, Fruit body.   C, Ascocarp In section.   D, Ascus with bifurcated paraphyses.   E, Ascospores.   F, Germination of ascospores.

ad maturitatem evadentia cymbiformia. Apothecia stromatica, uni-loculata, copulata labiis curvis, parietibus crassis, late ostiolata, 210–800 × 122·5–250 μ. Ordo stromaticus carbonaceus, ad

TABLE I

Species	Stroma	Ascocarp	Asci	Ascospores
H. januseœ Rehm.	Sessile, elongated, glabrous, longitudinal rings curved 2×0·5–0·75 mm.	Gregarious, paraphyses, branched	Clavate, 150–190×15 μ.	3-septate, rod-shaped, 21–25×9–10 μ
H. species (Indian)	Sessile, glabrous with a longitudinal slit 1–2 mm.	Isolated, cup-like, with curved lips paraphyses bifurcated at apex with epithecium above, 210–800×122·5–250	Cylindrical 122–224× 14·8 μ.	3-septate, elliptical, dark brown, 26–28×9·25–11·0 μ.

Unfortunately, *H. januseœ* Rehm. is incompletely described specially in respect of ascocarp characters, making comparison difficult. However, from the data available, Indian collection of *Hysterium* is not only considered distinct from *H. januseœ* Rehm. in respect of habit and morphological characters having bigger ascospores but has been collected on a hitherto

medium, crassior (65·0 μ), ad latera angustior (18·5 μ). Hypothecium pallide luteum, constans cellulis polygonalibus, 88·0 μ ad medium, 38·5 μ ad latera. Asci paralleli in seriebus basalibus, cylindrici, parietibus tenuibus, octospori; paraphysati, apparatu apicali nullo, 122·0–224 × 14·8 μ. Paraphyses ascis intermixtæ, tenues, hyalinæ, in parte basali non-septatæ, supra cero

septatæ, bifurcatæ, apicibus bulbosis; efformantes seriem epithecialem supra ascos. Ascosporæ brunneæ, ellipticæ uniformiter ter septatæ, constrictæ ad septum centrale, uniseriatæ, $26 \cdot 0$–$28 \cdot 0 \times 9 \cdot 25$–$11 \cdot 0 \, \mu$.

Typus lectus in surculis emortuis *Galphimiæ glaucæ* Cav., a V. S. Seshadri mensibus maritio-aprili, 1964 ad Poona in India et positus in M.A.C.S. sub-numero 187 (type).

Fresh ascospores germinated readily within 24 hours in sterilized water swelling in size in the process, giving out a stout germ-tube from a single cell of the ascospore, thus proving their non-resting nature.

This is a second record to India and the species is a second report in the family Malpighiaceæ on a new host.

The author's thanks are due to Prof. M. N. Kamat for his guidance, to Rev. Fr. Santapau for Latin rendering, and to C.S.I.R., New Delhi, for the award of a Junior Fellowship.

M.A.C.S. Laboratory,   V. S. SESHADRI.
Poona-4, *December* 3, 1964.

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HYPOXYLON TRUNCATUM (SCHW. *EX* FR.) MILLER VAR. *POUCEANUM* (BERK. *ET* COOKE) MILLER FROM MYSORE

IN the course of investigations on the 'die back' of coffee in Mysore State, the author, on several occasions, observed a species of *Hypoxylon* growing on the dead twigs of the coffee bush. The same species was also collected on the dead branches of shade trees, particularly species of *Ficus* growing in the coffee estates. We have no knowledge of the pathogenicity of this fungus either on coffee or ancillary shade trees. The following is a brief description of a composite collection assigned to *Hypoxylon truncatum* var. *pouceanum*.

Hypoxylon truncatum (Schw. *ex* Fr.) Miller var. *pouceanum* (Berk. *et* Cooke) Miller[1] (= *Hypoxylon pouceanum* Berk. *et* Cooke,

Grevillea, 11 : 130, 1883 ; = *Nummularia urceolata* Rehm., *Phil. J. Sci.*, 8 : 187, 1913) (Figs. 1, 2 and 3).

Stromata rather variable, erumpent, pulvinate, measuring up to 5 mm. in diameter, at first slate-grey in colour, later the stroma turns light brown and gradually to black, carbonous ;
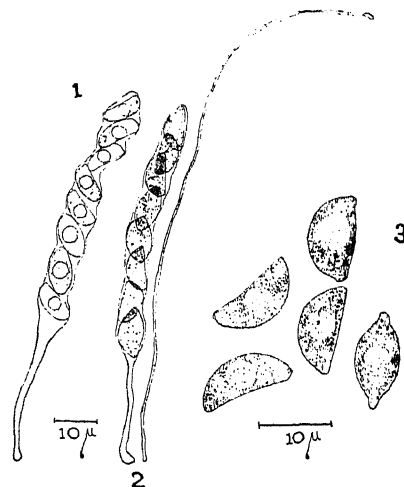
FIGS. 1–3. *Hypoxylon truncatum* (Schw. *ex* Fr.) Miller var. *pouceanum* (Berk. *et* Cooke) Miller on dead twigs of coffee. Figs. 1–2. Asci, ascospores and paraphysis. Fig. 3. Ascospores.

perithecial elevations very evident, up to 15 perithecia were seen in a group on the stroma, ostiola typically annulate, the disc being mostly $400 \, \mu$ wide. $(300$–$750) \, \mu$, perithecia semi-globose, up to 1 mm. in diameter ; cylindric, 60–90 μ by 6–7 μ with a stipe which is about 40 μ long, ascospores eight, diagonally uniseriate, inæquilaterally elliptic with obtuse ends, dark brown 10–15 by 4–5 μ paraphyses numerous filiform.

The author is grateful to the Divisional Manager, Fertilizer and Pesticides Division, Rallis India Limited and The Special Coffee Research Association for their encouragement and facilities given.

Rallis India Limited,   V. AGNIHOTHRUDU.
P.O. Box No. 68, Bangalore-1,
October 20, 1964.

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REVIEWS AND NOTICES OF BOOKS

Archimedes in the Middle Ages, Vol. 1. *The Arabo-Latin Tradition.* By Marshall Clagett. (The University of Wisconsin Press, Madison, Wisconsin), 1964. Pp. 720. Price $ 12.00.

The importance of the role played by Archimedes in the history of science can scarcely be exaggerated. He was emulated and admired in his own day and at successive periods in later times. His name appears on the pages of the works of the great figures who fashioned the beginnings of modern mechanics. For example, Galileo owed a not inconsiderable debt to Archimedes and mentions him over a hundred times, referring to him in terms of Homeric hyperbole. Archimedes' significance for these founders of early modern science lay in his use of mathematics in the treatment of physical problems as well as in the originality and fertility of his mathematical techniques.

The author's intention in the work has been to include all the known Archimedean texts from medieval period. The work has been carried out with thoroughness and scholarly acumen. The volume has been sumptuously produced and will be warmly welcomed by those interested in the history of mathematics.

<div align="right">C. V. R.</div>

The Concept of a Riemann Surface. By Hermann Weyl. Translated from German. (Addison Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A., and 10-15, Chitty Street, London W. 1), 1964. Pp. 191. Price $ 12.50.

Of interest to all students of pure and applied mathematics, this classic work on the general theory of functions provides an excellent foundation for those who wish to study the newer developments of the theory of analytic functions of several variables. The following topics are dealt with in this book : Concept and topology of Riemann surfaces : Weierstrass' concept of an analytic function. The Concept of an analytic form. The relation between the concepts "analytic function" and "analytic form". The concept of a two-dimensional manifold. Examples of surfaces. Specialization. Orientation. Covering surfaces. Differentials and line integrals. Homology. Densities and surface integrals. The residue theorem. The intersection number. Functions on Riemann Surfaces : The Dirichlet integral and harmonic differentials. Scheme for construction of the potential arising from a doublet source. The proof. The elementary differentials. The symmetry laws. The uniform functions as a subspace of the additive and multiplicative functions. The Riemann-Roch theorem. Abel's theorem. The inversion problem. The algebraic function field. Uniformization. Riemann surfaces and non-Euclidean groups of motions. Fundamental regions. Poincare θ-Series. The conformal mapping of a Riemann surface onto itself.

<div align="right">C. V. R.</div>

A Course of Mathematics for Engineers and Scientists. By C. Plumpton and B. H. Chirgwin. (Pergamon Press, Headington Hill Hall, Oxford.) Volume 4 : 1964. Pp. 353. Price 35 *sh.* net. Volume 5 : 1964. Pp. 202. Price 25 *sh.* net.

This work covers the mathematics required by science and engineering students during their undergraduate studies. The authors continually keep in mind the fact that the scientist requires answers and needs to apply mathematics to actual problems. Thus these volumes, besides giving basic knowledge, introduce techniques and provide manipulative practice ; the basic underlying methods for special or new mathematical techniques in science and engineering are fully examined. Numerous well-arranged and well-graded examples have been worked in the text and many more are available as exercises.

The aim of Volume 4 is to generalise and develop the ideas and methods of earlier volumes, so that students can appreciate and use the mathematical methods required in the more advanced aspects of physics and engineering.

The fifth volume contains the development started in Volume 4 of some more advanced topics. It is concerned almost entirely with the solution of differential equations with results obtained in various forms.

<div align="right">C. V. R.</div>

Advances in Heat Transfer, Vol. 1. Edited by Thomas F. Irvine and James P. Hartnett. (Academic Press, Inc., New York), Pp. xii + 459. Price $ 16.00.

This is the first volume of a series on the subject of heat transfer. In these days when science and technology are advancing fast and the number of publications is great, it is

difficult even for a specialist to keep a track of all the papers appearing in diverse journals. A publication of this type which brings the related advances under one cover should therefore be quite useful.

All the six chapters in the present volume are written by outstanding authorities in the respective fields and the subject-matter is developed in a logical fashion.   C. V. R.

Advances in Electronics and Electron Physics. Edited by L. Marton. (Academic Press, Inc., 111, Fifth Avenue, New York-3, New York.) Volume 18 : 1963. Pp. x + 342. Price $ 12.50. Volume 19 : 1964. Pp. x + 323. Price $ 12.00.

Each article in this well-known series is accompanied by an extensive bibliography which enhances its utility to the reader.

Volume 18 contains the following articles : (*i*) The Nightglow, by F. E. Roach ; (*ii*) Recent Developments in Computer Organization, by F. P. Brooks, Jr.; (*iii*) Atomic Collisions Involving Low Energy Electrons and Ions, by Manfred A. Biondi ; (*iv*) Semiconductor Device Evaluation, by David P. Kennedy ; and (*v*) Electron Emission Microscopy, by G. Mollenstedt and F. Lenz.

Volume 19 contains the following articles : (*i*) Electronic Instrumentation for Oceanography, by Allen H. Schooley ; (*ii*) Radio Wave Scattering in the Ionosphere, by K. L. Bowles ; (*iii*) Properties, Measurement, and Bioclimatic Action of "Small" Multimolecular Atmospheric Ions, by M. Knoll, J. Eichmeier and R. W. Schon ; and (*iv*) Endfire Antennæ, by G. Broussaud and J. C. Simon.   C. V. R.

Animal Chemistry or Organic Chemistry in Its Application to Physiology and Pathology. By Justus Liebig. (Johnson Reprint Corporation, 111, Fifth Avenue, New York), 1964. Pp. 504. Price $ 14.50.

This is a reprint of the English translation published at Cambridge in the year 1842 of Liebig's classic work. It is prefaced by an introduction by Frederick L. Holmes covering 106 pages, which surveys the history of the subject both before and after Liebig worked on it. Despite the vast developments which have since taken place, Liebig's treatise in the field claims the interest and attention of those working in the field. For, unquestionably, it played a great role in the creation and development of the modern science of biochemistry. The reprint of the volume is thus a useful and fully justified enterprise of the publishers.   C. V. R.

Advances in Electronics and Electron Physics, Supplementary Volume. By Henry F. Ivey. (Academic Press, Inc., 111, Fifth Avenue, New York 3, New York), 1963. Pp. xii + 276. Price $ 11.00.

The subject of electroluminescence and related effects is handled in this volume in four chapters : (*i*) Mechanisms of Electroluminescence ; (*ii*) Electroluminescence in Zinc Sulfide and Related Phosphors ; (*iii*) Electroluminescence in other Materials ; and (*iv*) Field Effects in Excited Phosphors. This volume should be useful to those interested in this actively growing subject.   C. V. R.

Dictionary of Science. By E. B. Uvarov, D. R. Chapman and Alan Isaacs. (Revised Edition). (Penguin Books Ltd., Middlesex, England), 1964. Pp. 336. Price 5 *sh.*

The newly issued Third Edition of the Penguin Reference book has been revised by the third author Dr. A. Isaacs. It contains nearly 100 more pages than the previous edition and includes over a 1000 new entries. The largest number of new entries relate to nuclear physics and space science. An appendix of six tables, namely the periodic table and the table of elements, the solar system, table of amino-acid, differential coefficients and integrals and spectrum of electromagnetic radiations is a welcome new feature in this edition.

    A. S. G.

Selected Experiments in Physical Chemistry. By J. L. Latham, D. A. Jenkins and G. R. H. Jones. (Butterworth & Co., 88, Kingsway, London W.C. 2), 1964. Pp. xi + 124. Price 12 *sh.* 6 *d.*

This book can be recommended as a laboratory guide book for students of physical chemistry in degree classes. The selection contains 40 experiments to illustrate important principles in physical chemistry. Instructions to carry out the experiments are given in a methodic and clear manner. Only the essentials of the theory to understand the experimental procedure are indicated. For theoretical details the student is referred to corresponding pages in the well-known text-book *Elements of Physical Chemistry* by Glasstone and Lewis.

Part I of the book contains 27 experiments in general physical chemistry, and Part II 13 experiments on analytical applications of physical chemistry with special reference to end-point detection.

The low price of the book will enable individual student to own a copy of this useful laboratory manual. A. S. G.

Introduction to Electroanalysis. By L. L. Leveson. (Butterworths, London W.C. 2), 1964. Pp. vii + 120. Price 15 *sh.*

Electrochemical methods of analysis like potentiometry, voltammetry, amperometric titration, coulometry and conductometry have become well recognized techniques now and they are being increasingly used in industry and research. Hence emphasis on these methods is being placed in the curricula of college and advanced technological courses. This little book giving clear and concise information on the above-mentioned topics will meet the need of the students as an introduction to the subject of electroanalysis. A. S. G.

Stress Waves in Solids. By H. Kolsky. Price $ 1.55.
Basic Methods in Transfer Problems. By V. Kourganoff. Price $ 2.00.
Analytical and Canonical Formalism in Physics. By Andrè Mercier. Price $ 1.75.
(Dover Publications, Inc., 180, Varick Street, New York-14, N.Y.).

Developments of electronic techniques for the production and measurement of elastic waves of high frequency have revived interest in theoretical considerations of stress waves in solids. Again, the development of new materials has called for fresh appraisal of propagation of waves through bodies which are not perfectly elastic. Kolsky's monograph which was originally published by the Clarendon Press, Oxford, in 1953, gives a concise account of the classical theory of wave propagation in elastic solids, shows how this theory has been extended to solids which are not perfectly elastic, and then summarizes the experimental work carried out in recent years. The book is in two parts, the first part dealing with Elastic Waves, and the second part with Stress Waves in imperfectly elastic media. An appendix includes new material on waves in modern plastic substances.

In his book on Transfer Problems, Kourganoff gives an account of the methods which are available for solutions of radiative transfer problems, and in partciular he has chosen Milne's problem for a plane parallel medium and demonstrates the application of the different mathematical methods to solve the characteristic features involved in this problem. Material from recent Russian scientific literature has been incorporated in the book.

Andrè Mercier's book, first published in 1959 by the North-Holland Publishing Company, deals with the various formalisms used in modern Field Theories. The topics dealt with are : The Lagrangian Formalism, Lagrangian Densities, Canonical Formalism, Canonical Form of Electrodynamics, Hamiltonian Densities, Transformations, Canonical Formalism with Vanishing Jacobian Determinant. The book is intended for advanced students and teachers. Examples to illustrate the theory are distributed throughout the text. A. S. G.

The Physical World—An O-Level Course (Vol. 1)—*Mechanics.* By H. J. P. Keighley and F. R. McKim. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. xv + 223. Price 15 *sh.*

This publication (in three volumes) is an elementary text-book in physics written on modern lines which can be recommended for use in Indian schools for the pre-secondary course. Written by two experienced senior science masters, the book covers the 'O' level physics syllabus according to the Science Masters' Association recommendation. The book is beautifully produced with numerous illustrations and photographs to give a clear understanding of the fundamental principles of mechanics and their applications to familiar every-day happenings.

Teachers will find this publication a useful reference text, and pupils after reading each chapter will be enthused to do their own experiments to test the laws or 'rediscover' them for themselves.

This first volume on Mechanics exhibits a high standard of production and it is hoped that the succeeding two volumes will be equally attractive. A. S. G.

Advances in Immunology (Vol. 3). Edited by F. J. Dixon, Jr. and J. H. Humphrey. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xi + 408. Price 93 *sh.*

While immunology has made rapid strides in recent times, the large amount of data obtained has still to be integrated to a discernible skein.

The reviews presented in this volume are of great topical interest. Some of the concepts and speculations of the authors are radical in their approach and challenge many accepted tenets of immunological phenomenon.

It is well known that the symptom complex exhibited during systemic anaphylaxis varies from species to species. Increasing volume of evidence suggests that the main part of the symptom complex is caused by the release of pharmacologically active agents or their activators. It is a tenable thesis that the mechanism whereby the chemical mediators are released is very similar in different species.

In the *in vitro* studies of anaphylaxis, the several model systems which have been investigated during recent years have been described and an attempt has been made to draw these together so as to make clear the extent to which the underlying mechanisms follow common or divergent patterns.

Humoral isoantibody formation, once thought to be inconstant now appears to be an ineluctable feature of iso-immune response to tissue homografts. Most of the formal demonstrations point to a central role for conventional antibody in the destruction of the homografts. These aspects are discussed under 'The role of humoral antibody in the homograft reaction'.

'Immune adherence' gives a clear picture of the nature of the adherence, its relation to other similar reactions, specificity and sensitivity as an immunological technique and its possible biological significance.

Reagin still represents a nebulous concept to many immunologists. 'Reaginic Antibodies' reviews the biological and physico-chemical properties of reaginic antibodies and presents the results of investigations on artificially induced skin sensitizing antibodies. An interesting 'Immuno chemical' theory of reagin formation has been proposed by the authors to explain many of the peculiarities of immediate type hypersensitivity reactions.

The role of antigen in antibody formation has, so far, not had the deserved attention. 'Retained antigen and immune mechanisms' review some aspects of this study related to the retention, tissue localization and excretion of antigens in responsive and unresponsive animals, and the characterization of and immune responses from such retained antigens.

The combined efforts of geneticists and immunologists have resulted in substantial progress in the field of animal blood groups. 'Blood groups in animals other than man' presents the principal findings concerning animal blood groups.

M. SIRSI.

Books Received

Child Development—A Symposium. (National Council of Educational Research and Training, New Delhi-11), 1964. Pp. 353. Price Rs. 15·00.

Organizing a Village Library. By S. R. Mittal. (National Council of Educational Research and Training, New Delhi-11), 1964. Pp. 28. Price 40 P.

Simple Visual Aids for Social Education. By S. L. Ahluwalia. (National Council of Educational Research and Training, New Delhi-11), 1964. Pp. 23. Price Re. 0·85.

Chemical Transport Reactions. By H. Schafer. (Academic Press, New York), 1964. Pp. xiii + 450. Price 100 *sh.*

Advances in Agronomy (Vol. 16). By A. G. Norman. (Academic Press, New York), 1964. Pp. xi + 414. Price $ 13.50.

Atoms, Molecules and Quanta. By A. E. Ruark and H. C. Urey. (Dover Publications, 180, Varick Street, New York-14), 1964. Vol. 1: Pp. xvi + 447. Price $ 2.50; Vol. 2: Pp. vi + 448–810. Price $ 2.50.

Progress in Oceanography (Vol. 2). Edited by M. Sears. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. v + 271. Price 80 *sh.*

Advances in Protein Chemistry (Vol. 19). Edited by C. B. Anfinsen, M. L. Anson, J. T. Edsall and F. M. Richards. (Academic Press, New York), Pp. viii + 408. Price $ 14.50.

Progress in Experimental Personality Research (Vol. 1). Edited by B. A. Maher. (Academic Press, New York), 1965. Pp. x + 368. Price $ 9.50.

Documents on Modern Physics—Motion of Charged Particles in the Earth's Magnetic Field. By J. W. Chamberlain. (Gordon and Breach, 150, Fifth Avenue, New York-11), 1964. Pp. ix + 33. Price $ 3.95.

Refractory Transition Metal Compounds High Temperature Cermets. By G. V. Samsonov. (Academic Press, Inc., New York), 1964. Pp. viii + 220. Price $ 9.00.

Rare Earth Research (II). Edited by K. S. Vorres. (Gordon and Breach, New York-11), 1964. Pp. xvi + 621. Price $ 29.50.

Advanced Methods of Crystallography. By G. N. Ramachandran. (Academic Press, Inc., London, Ltd., London W. 2), 1964. Pp. ix + 279. Price 65 *sh.*

Techniques in Experimental Virology. Edited by R. J. C. Harris, 1964. Pp. xiii + 450. Price 100 *sh.*

SCIENCE NOTES AND NEWS

A New I.S.I. Publication

The Iron and Steel Institute is to publish early in 1965 *World Calendar of Forthcoming Meeting: Metallurgical and Related Fields*. This new publication will contain basic information about meetings anywhere in the world concerned with ferrous and non-ferrous metallurgy, production, working properties of metals, their related engineering and other technologies, and services.

The basic details to be provided will be : date, location, theme or title, organising body, and address for enquiries ; where it is available, etc.

The entries will appear in chronological order and each copy will contain three indexes : short title, place and organising body. Every issue, of which there will be six a year, will cover a period of about two years and will be cumulative within that period.

Subscription rates are £ 5.5 *sh.* and further information can be obtained from The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1.

Proteins from Petroleum Fermentation

It has been known for some years that a large variety of micro-organisms live and actively reproduce themselves at the expense of hydrocarbons in storage tanks, refinery slop tanks, ground saturated with oil, and even under the bituminous covering of roads. Work to evaluate the possibilities offered by such micro-organisms which metabolize hydrocarbons has been going on for the past eight years at the microbiological research laboratory of the Lavera Refinery of the Societe Francaise des Petroles B.P., an associate of the British Petroleum Company.

The following facts have emerged from these researches : (a) a large number of micro-organisms can adapt themselves to grow at the expense of petroleum fractions as the sole source of carbon and energy ; (b) a certain number of micro-organisms metabolize for preference the normal paraffin hydrocarbons of petroleum fractions, and leave the others practically unaltered ; and (c) by choosing suitable culture conditions, the growth of these micro-organisms on petroleum is as rapid as in the traditional sugary environment.

Laboratory experiments have further shown that the petroleum-based micro-organisms are rich in proteins that contain all the amino-acids required to sustain animal life, and that they are present in roughly the same proportions found in proteins obtained from animal sources. The petroleum-based micro-organisms when dried and suitably purified appear in the form of a powder or of whitish flakes, without noticeable taste or smell of petroleum when they are sufficiently free from lipides. Thus they can be incorporated into traditional cereal-base foods to supplement their proteins.

Further, the fact that these micro-organisms can be used as deparaffination agents opens up attractive perspectives for the petroleum industry. The presence of the normal paraffins in certain fractions of petroleum, such as heavy gas-oils, raises their pour point which prevents their use as fuels for diesel engines or for domestic heating. Physical methods of deparaffining these fractions are known, but these methods leave enormous quantities of unsaleable paraffin on the market.

The work on the biosynthesis of concentrated proteins from petroleum by the research group of Lavera Refinery, and its scope as aid to the world food problem in the long-term future is brought out in an article by the Research Director A. Champagnat in the UNESCO publication.—(*Impact*, 1964, 14, No. 2.)

Superstrong Magnets

The magnet at the Naval Research Laboratory in Washington is one of the strongest magnets known and it produces a continuous magnetic field (*i.e.*, a field that can be sustained for at least a minute) of 152,000 gauss. A direct-current water-cooled magnet at the National Magnetic Laboratory, M.I.T., creates a continuous field of 255,000 gauss. It is a three-coil solenoid that draws its power from generators able to supply direct current up to 40,000 amperes at 250 volts. Efforts to produce higher fields encounter the problem of containing the large forces involved ; in the M.I.T. magnet, for example, these are of the order of 60,000 pounds per square inch.

C. M. Fowler of the Los Alamos Scientific Laboratory has developed an implosive technique which promises million-gauss fields to be obtained, though for *fleeting instants* only. In this technique a metal ring in which a magnetic field up to 100,000 gauss is created, is surrounded with an explosive which is detonated in such a way that the ring is compressed symmetrically. The magnetic field increases as the area of the ring decreases. In this way fields

as high as 15 million gauss have been obtained. What remains to be developed is a technique for making observations during the microsecond duration of the field and under the destructive circumstances of the implosion.—(*Sci. Amer.*, January 1965.)

Effect of Physical Conditions in the Sea on Fisheries

The yields of many of the major sea-fisheries are widely variable from season to season and from year to year, even from decade to decade. In some cases, these fluctuations are known to be related to large-scale changes of the physical conditions in the sea.

Off the north-west coast of South America (Peru-Ecuador) the pulsation of warming and cooling in the eastern Pacific reaches an apogee every 5 to 8 years in a phenomenon so sharply evident in the whole area as to have earned a distinctive name, 'El Nino'. The cause of this phenomenon is still uncertain, but its effect is a spilling of warm tropical water in a thin skin over the normally cold up-welled water to a variable distance down the Peruvian coast. In this area lies the largest single species fishery in the world (for anchovy, *Engraulis*), large fisheries for yellowfin, shipjack tuna and bonito, and a very numerous oceanic bird population producing the guano of commerce. The effect of 'El Nino' on the production of the fisheries and of guano is catastrophic. It brings about a mass mortality of aquatic life and guano birds.

Coming nearer home, about 80% of the marine fish catch of India is made on the west coast, the old Malabar and Kanara coast. The prime components of the catch by volume are the oil sardine (*Sardinella longiceps*) and the Indian mackerel (*Rastrelliger canagurta*). Both are subject to very wide fluctuations in yield. Some of the year-to-year vagaries of the sardine catch are : 72,000 tons in 1933-34 compared to 1,123 tons in 1932-33, 25,269 tons in 1940-41 and 9 tons in 1946-47 ; 7,412 tons in 1956 and 191,469 tons in 1957. The sardine peaks sharply during the transition period between monsoons, when the cool low-salinity coastal waters characteristic of the south-west monsoon are replaced by the warm saline waters of the north-east monsoon. In the past ten years the mackerel catch, while not so widely variable as that for sardine, has ranged from 103,574 tons in 1951 to 15023 tons in 1956, and to 86,741 tons in 1957. Generally speaking, when the sardine catch is up, the mackerel catch is down, and *vice versa*.—(*Impact*, UNESCO, 1964, 14, No. 3.)

Fourth Test of General Relativity

Recent advances in radar astronomy have made possible a fourth test of Einstein's theory of general relativity. The test involves measuring the time delays between transmissions of radar pulses towards either of the inner planets (Venus or Mercury) and detection of the echoes. Because, according to the general theory, the speed of a light wave depends on the strength of the gravitational potential along its path, these time delays should thereby be increased by about 2×10^{-4} sec. when the radar pulses pass near the Sun. Such a change, equivalent to 60 km. in distance, could now be measured over the required path length to within about 5 to 10% with presently obtainable equipment.

I. I. Shapiro of the Lincoln Laboratory, M.I.T., discusses the possibility of these observations by the Arecibo Ionospheric Observatory, and for the Haystack radar at M.I.T. Although Mercury passes through superior conjunction about once in four months, some passages are considered more useful than others from the points of view of ease of detectability and of close angular approach to the Sun. The most favourable in the next two years occur on 11 June 1965 (minimum angular distance 1°) and 27 May 1966 (0·5°). The superior conjunctions of Venus are less variable and usually lead to an angular distance of closest approach of about 1°, as in the next two which will be on 12 April 1965 and 9 November 1966.—[*Phys. Rev. Letters*, 1964, 13 (26), 789.]

Experiment to Observe Photon-Photon Scattering

With the existing technology it seems practicable to conduct experiments for the detection of photon-photon scattering in vacuum. The experiment is based on the possibility of producing a well-directed and intense burst of radiation by means of an "X-ray flashbulb", an otherwise conventional X-ray tube through which a very large current (about 200,000 amperes at an anode-cathode potential difference of 3 million volts) is maintained for a very small time (about 5 microseconds). It is estimated that about 10–20 photon-photon scattering events can be initiated by two such X-ray flashbulbs, properly oriented and synchronized to flash together in an appropriate experimental arrangement. The detection of mutually scattered photons should involve no serious difficulty and, in fact, this method has several practical advantages over similar experiments with gamma beams.—(*Phys. Letter*, 1965, 14, 201.)

THE NEW PHYSIOLOGY OF VISION
Chapter XIV. The Red End of the Spectrum

Sir C. V. RAMAN

IN the present chapter, we shall concern ourself with the visual sensations excited by light of wavelengths between 579 mμ and the long-wave limit of the visible spectrum. Some of the features of this region which are evident to simple inspection may first be mentioned. The yellow at 579 mμ is followed by the region in which the hue passes from yellow to red through various intermediate colours usually termed as orange. This region extends up to about 630 mμ and it is highly luminous. From 630 mμ to 660 mμ the colour is red, but the luminosity of the spectrum falls off. This is followed by a region in which there is a further rapid diminution in brightness. Beyond 690 mμ, the spectrum becomes excessively feeble.

It is a remarkable and indeed significant fact that it is not possible by observation to fix a definite wavelength as that beyond which the red of the spectrum ceases to be observable. It is found, for example, that an observer who views the highly luminous part of the sky in the vicinity of the sun through a pocket spectroscope would be inclined to place the limit at 700 mμ. But if, on the other hand, he directs the same instrument towards the blue sky far away from the sun, he would find that nothing can be seen of the spectrum beyond 670 mμ. Likewise, if inside a room illuminated by diffuse daylight, the same instrument is directed towards a whitewashed wall, he would decide that the spectrum terminates at 650 mμ, but also exhibits a rapid fall of intensity between 630 mμ and 650 mμ.

The experiences set forth above become intelligible when we consider the spectroscopic behaviour of the visual pigments functioning in the long-wave region of the spectrum. The data regarding their properties were already set out in an earlier chapter, but are here reproduced again as Fig. 1 covering the spectral range between 500 mμ and 800 mμ. The graphs have been copied from the chart appearing at the end of the volume by Lemberg and Legge entitled *Hematin Compounds* (Interscience, New York and London, 1949). The most conspicuous feature noticeable in the figure is the rapid diminution in the molecular extinction coefficient of all the three pigments which exhibits itself as we proceed towards longer wavelengths. But as between the three, there are noteworthy differences. The ferrous form of the heme pigment exhibits a wide-band maximum located at about 560 mμ, its absorption falling off to a small fraction of that value for wavelengths greater than 650 mμ. The oxygenated form of the heme pigment exhibits a sharply defined peak at 579 mμ coinciding with the yellow of the spectrum; following this, there is an extremely rapid fall of the molecular extinction coefficient, its value becoming quite small at 600 mμ and entirely negligible at 650 mμ. The ferric form of the heme pigment has high values of the extinction coefficient in the spectral range between 600 mμ and 630 mμ, in other words, in the range of wavelengths in which the perceived colour exhibits the transition from orange to red. There is a well-defined maximum at 630 mμ. Beyond 630 mμ, the extinction coefficient drops off very rapidly and becomes quite negligible at 700 mμ.
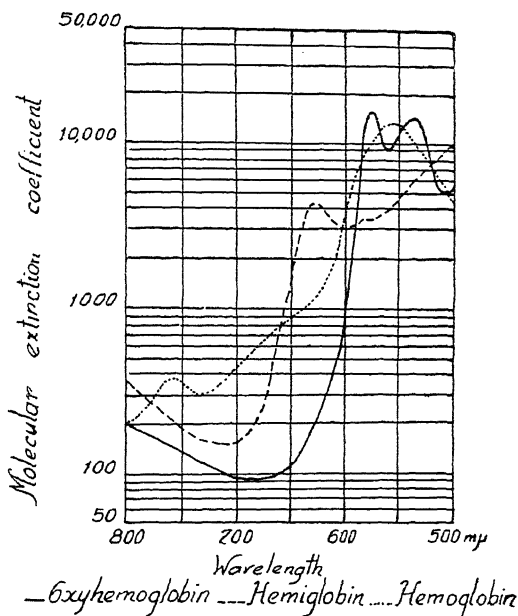
FIG. 1. Light Absorption Curves

What has been stated above enables us to arrive at certain conclusions. Firstly, it is the ferric form of the heme pigment which principally enables us to perceive the orange and the red sectors of the visible spectrum. The properties of that pigment also explain why the visible spectrum in the wavelength range between

600 mμ and 630 mμ exhibits a high luminosity, why that luminosity diminishes rapidly in the range between 630 mμ and 660 mμ, why the red of the spectrum becomes extremely weak in the spectral range between 660 mμ and 700 mμ and why except at very high levels of illumination it ceases to be observable beyond 700 mμ. Further, since the observable extension of the spectrum depends on the level of illumination, we may expect that the entire red of the spectrum would disappear and cease to be visible and would be followed by the orange sector as well, when that level is lowered sufficiently.

The Purkinje Phenomenon.—The disappearance from sight of the red region in the spectrum has, in the past, been believed to be a characteristic feature of vision in dim light and to require the adaptation of the eye to low levels of illumination. That these beliefs are erroneous will be evident from what has been stated above. Actually, the Purkinje phenomenon arises by reason of the spectroscopic properties of the visual pigments which function in bright light and it is observed in circumstances that do not require the adaptation of the observer's vision to dim light. These inferences have been confirmed and firmly established by the author's studies using several different techniques which will presently be described. The essence of the matter is that the disappearance of **red** light from the visible spectrum is a progressive phenomenon. It commences at quite high levels of illumination for the longest waves and proceeds towards shorter wavelengths with diminishing illumination, till finally the entire spectrum of wavelengths greater than 600 mμ drops out of sight.

A simple and convenient procedure for demonstrating the real nature of the Purkinje phenomenon is to examine the spectrum of skylight visually using a pocket spectroscope. The most suitable time for such observations is either in the morning just before sunrise or in the evening just after sunset, when the illumination of the sky by the sun's rays traversing the higher levels of the atmosphere is sufficiently strong to enable the spectrum of every part of the sky to be seen through such an instrument clearly and without the least difficulty. Observations made under these conditions belong to the category of vision in bright light. Indeed, the spectrum itself exhibits features which distinguish it sharply from the spectrum of dim light. But it differs from the spectrum of skylight as seen at other hours by reason of the extreme weakness or total absence of the parts of the spectrum of which the wavelengths exceed 600 mμ.

The character of the spectrum as actually observed in the conditions stated above is determined by the luminosity of the part of the sky under view. Naturally, therefore, it varies with the direction of observation and alters as the sun comes up towards the horizon or goes down below it. The general sequence of the changes observed is however the same in all cases. Indeed, except in the areas close to the position of the sun, we observe the same effects almost simultaneously in all parts of the sky. In the first stage, there is a progressive shortening of the length of the spectrum, wavelengths greater than about 650 mμ ceasing to be visible. In the second stage, there is a progressive fall in the brightness of the spectrum between 600 mμ and 650 mμ as compared with the spectrum between 500 mμ and 600 mμ. In the final stage, the region of the spectrum beyond 600 mμ passes out of sight, while the region between 500 mμ and 600 mμ continues to be conspicuously visible. The maximum brightness in the latter region appears at about 550 mμ ; its colour is a bright green and quite different from the colour observable in the region of wavelengths less than 500 mμ. The latter regions are also much less luminous than the spectrum between 500 mμ and 600 mμ. It is clear from these facts that the Purkinje phenomenon falls within the category of vision in bright light and is no way related to the characteristics of vision in dim light.

That red light ceases to be visible at levels of illumination higher than those falling within the range of dim-light vision can be further demonstrated in the following simple fashion. A large plastic sheet of red colour with faces exhibiting a smooth polish is set up facing the observer at a distance of a few metres from him. Alongside of it and at the same distance from the observer, is placed a Snellen test-chart with printed rows of letters of the kind used by ophthalmologists. The illumination of the red plastic sheet and of the test-chart is controlled by varying the opening of a large iris-diaphragm through which skylight enters the otherwise darkened room. It is then found that the red screen becomes darker and finally turns black when the iris is closed down sufficiently, while on the other hand the printed types of the Snellen chart continue to be visible and can be read from a distance without difficulty. Spectroscopic examination shows that the light diffused by the plastic sheet appears in the

spectral range between 580 mμ and 700 mμ, while the rest of the spectrum is completely absorbed by the material of the screen. The Purkinje phenomenon thus extends over the entire range of wavelengths between the yellow and the extreme red of the spectrum.

Other Methods of Observation.—The conclusion thus reached is that in the familiar Newtonian sequence of colours exhibited by a continuous spectrum, the hues ranging from yellow to the deepest red disappear in the reverse order as the illumination reaching the eye is progressively reduced. It is evidently desirable that this result which is of fundamental importance in the physiology of vision is demonstrated with artificial light sources having a continuous spectrum and a controlled intensity under laboratory conditions. This can easily be arranged. A convenient technique is to use as the source of light a 100-watt tungsten filament-lamp with a frosted bulb. The spectrum seen when the pocket spectroscope is held close to the bulb is, of course, extremely brilliant. The yellow region is its most conspicuous feature and the orange and red which follow it can be seen extending up to 700 mμ. To obtain a controlled and progressive reduction of brightness, a useful device is to hold a sheet of opal glass 2·5 millimetres thick between the lamp and the observer. The spectrum of the light emerging through the sheet is viewed with the pocket spectroscope held behind it. The reduction of luminosity resulting from the insertion of the sheet of opal glass between the lamp and the observer is very striking. Indeed, the entire sequence of changes in the spectrum from one exhibiting the features characteristic of high illumination to one in which all wavelengths greater than 600 mμ have disappeared from sight can be followed merely by the observer holding the opal glass sheet and the spectroscope and moving away from the lamp to the further end of the laboratory a few metres away. To observe the same sequence without the aid of the opal glass sheet would require a movement which is far larger. Incidentally, it may be mentioned that the disappearance of the red end of the spectrum is well exhibited by distant street lights when they are viewed through a pocket spectroscope.

Another technique by which the real nature and characteristics of the Purkinje phenomenon can be effectively displayed requires the use of a straight metallic filament stretched along the axis of a tubular lamp and heated by an electric current. At a convenient distance from the lamp, the observer holds a replica diffraction grating before his eye and views the first-order diffraction spectrum of the luminous filament. When this is glowing at a white heat, the spectrum exhibits its greatest extension both towards the violet and towards the red; the spectrum is seen extending to 700 mμ or even a little beyond. A reduction of the heating current has the effect of weakening the entire spectrum, especially the region of shorter wavelengths and ultimately of extinguishing the latter. But the green sector of the spectrum continues to be visible, and the noteworthy feature is the progressive shortening of the red sector of the spectrum. As the heating current is reduced, the red in the spectrum then becomes weaker and weaker relatively to the green region and finally disappears, while the green continues to be visible. This, in fact, is the Purkinje phenomenon and proves that it is a progressive diminution in the visibility of the spectrum which commences at 700 mμ and ends up with the complete extinction of the spectrum beyond 600 mμ.

Observations with Colour Filters.—The characteristic features of the Purkinje phenomenon set forth above may be further demonstrated in a striking fashion by the aid of colour filters which transmit limited regions of the spectrum in the wavelength range between 600 mμ and 750 mμ but cut off the rest of that spectral range. Three such filters have been made use of by the author, prepared by staining gelatine plates respectively with the dye-stuffs (*i*) disulphine blue, (*ii*) coomassie brilliant blue and (*iii*) methyl violet. The transmission bands of the three filters covered the following wavelength ranges: (*i*) 700 mμ to 730 mμ, (*ii*) 650 mμ to 700 mμ and (*iii*) 630 mμ to 670 mμ.

The luminosity of these strips of transmission in the red region of the spectrum relatively to the parts of the spectrum in the wavelength range between 500 mμ and 600 mμ passed by the filters can be observed by viewing a continuous spectrum through the filters. It is found to depend to a very great extent on the brightness of the light source employed. It is also very different for the regions of the spectrum in the red transmitted respectively by the three filters.

Concluding Remarks.—We may sum up the results which have emerged by the statement that the Purkinje phenomenon owes its origin to the spectroscopic properties of the ferric form of the heme pigment. The observed characters of that phenomenon are a demonstration of the correctness of the identification of the ferric form of heme as the visual pigment which functions in the red sector of the spectrum.

THE DYNAMICAL ORIGIN OF SYMMETRY OF ELEMENTARY PARTICLES *

E. C. G. SUDARSHAN

Physics Department, Syracuse University, Syracuse, New York

1. INTRODUCTION

ONE of the most remarkable features of elementary particles is their multiplet structure. The simplest such structure is the particle-antiparticle pairing with equal mass, spin, lifetime, etc., but with opposite charge (and baryon number, hypercharge, etc.). We relate this regularity to the TCP invariance of the theory, though in earlier years we would have considered the regularity to be a consequence of charge conjugation invariance. We may say that we understand the origin of the particle-antiparticle symmetry.[1]

But among the strongly interacting particles we see multiplets of particles with equal spin and parity, but only approximately equal mass. It is conventional to identify such a multiplet structure with the manifestation of an internal symmetry group, the multiplets constituting irreducible representations of this group. Charge independence of strong interactions is now well established, and it is not inconsistent to assume that the deviations from exact charge independence are due to the charge dependent coupling with the radiation field : though it is by no means true that this is the only possible mechanism of violation of charge independence. By now it is also well established that there are regularities in the particle (and resonance) spectrum which go beyond charge independence, in the sense that the multiplets can be further grouped together to constitute supermultiplets with the same spin, parity and baryon number and comparable masses, which constitute irreducible representations of the special unitary group in three dimensions.[2] In this case the departures from symmetry are not easily blamed on a known non-strong interaction, but have to be ascribed to a "small" part of the strong interactions themselves.

All along, the framework was one in which the symmetry group was "given". As long as the perturbations are neglected, the particles and resonances are to constitute irreducible multiplets, with the coupling constants being

proportional to the Clebsch-Gordan coefficients. But as to which multiplets occur, or as to the identification of observed particles with irreducible representations, the theory is silent. The difference between the Sakata and the Gell-Mann-Ne'eman versions of SU_3 is a case in point. A simple-minded suggestion is that the lowest dimensional representations of the group only occur. There are at least two shortcomings to this point of view : first, it does not tell which of the "smaller" representations actually occur and the order of their masses ; second, one has to invoke extraneous considerations to eliminate the triplet (and sextet, etc.) representations of the unitary group. In view of these, it is worthwhile to seek a more intimate connection between the symmetry group and the dynamics of the system.

There is another line of development which makes such a connection even more desirable. In a dynamical scheme, where the particles or resonances appear in the direct channel of a two-particle scattering process as a result of the exchange of these and other particles or resonances in the crossed channels, there are self-consistency demands on the number of particles or resonances in a multiplet and on the relative magnitudes of the various coupling constants ; and the multiplets that can be exchanged to give an *attractive* force are not arbitrary.[3] Thus there is a possibility of seeking a dynamical origin of symmetries, *starting from the existence* of (mass-spin-parity degenerate) *multiplets of interacting particles* and requiring self-consistency. In addition to the need of self-consistency, in most such attempts to-date, one includes other conservation laws, like conservation of baryon number, electric charge, hypercharge, etc. As a result of these, with restriction to equal masses of the particles within a multiplet, the problem of dynamical self-consistency reduces to a set of algebraic non-linear equations. In case these equations lead to a symmetry group, the group comes equipped with the specific representations furnished by the interacting multiplets.

Essentially the same, but weaker, equations follow from considerations of an entirely different nature. In this, one again starts from the existence of (mass-spin-parity degenerate)

multiplets but *extends* the identity of their *one-particle properties to particles in interaction* by requiring that the two-point (*i.e.*, one-particle) *propagators* of the interacting "particles" belonging to the multiplet are identical.[4] No questions of self-consistency are necessary in this scheme, but the equations derived by isolating and equating suitable terms in the different propagators serve more or less the same purpose as the self-consistency equations in establishing a dynamical origin of symmetries. Again, as before, the groups come equipped with the irreducible representations furnished by the interacting multiplets.

2. SMUSHKEVICH EQUATIONS FROM FIELD THEORY

Consider three multiplets of interacting particles E, F, ϕ with m, n and ν members. Then the dynamical principle of equal propagators require that

$$G^{E}_{rr'}\,(x - y) = \delta_{rr'}\,G^{E}\,(x - y)$$
$$1 \leqslant r,\,r' \leqslant m \qquad (1\,a)$$

$$G^{F}_{ss'}\,(x - y) = \delta_{ss'}\,G^{F}\,(x - y)$$
$$1 \leqslant s,\,s' \leqslant n \qquad (1\,b)$$

$$G^{\phi}_{aa'}\,(x - y) = \delta_{aa'}\,G^{\phi}\,(x - y)$$
$$1 \leqslant a,\,a' \leqslant \nu. \qquad (1\,c)$$

Here G^{E}, G^{F}, G^{ϕ} are appropriate Green functions. The essential point is the appearance of the Kronecker delta on the right-hand side, and it is a consequence of the requirement that the propagators be equal for any two members of the multiplet, since we have the freedom to redefine the components using any unitary transformation :

$$E_{r}\,(x) \rightarrow E'_{r}\,(x) = \sum_{r'} U_{rr'}\,E_{r'}\,(x) \qquad (2\,a)$$

$$F_{s}\,(y) \rightarrow F'_{s}\,(y) = \sum_{s'} W_{ss'}\,F_{s'}\,(y) \qquad (2\,b)$$

$$\phi_{a}\,(\xi) \rightarrow \phi'_{a}\,(\xi) = \sum_{a'} V_{aa'}\,\phi_{a'}\,(\xi) \qquad (2\,c)$$

We now assume that there exists a non-vanishing trilinear vertex (Fig. 1) coupling the particle multiplets E, F, ϕ which is of the form

$$\Gamma^{a}_{r,s}\,(x, y, \xi) = g^{a}_{rs}\,\Gamma\,(x, y, \xi) \qquad (3)$$

By isolating the contribution from two-particle intermediate states (Fig. 2) to the propagators (1) we get the bilinear relations

$$\sum_{a,s} g^{a}_{rs}\,(g^{a}_{r's})^{*} = A_{1}\,\delta_{rr'} \qquad (4\,a)$$

$$\sum_{a,r} g^{a}_{rs}\,(g^{a}_{rs'})^{-} = B_{1}\,\delta_{ss'} \qquad (4\,b)$$

$$\sum_{r,s} g^{a}_{r,s}\,(g^{a'}_{rs})^{*} = C_{1}\,\delta_{aa'} \qquad (4\,c)$$

It is convenient to introduce a matrix notation at this point, identifying g^{a}_{rs} as the (r, s) matrix element of the matrix g^{a}. Then we can rewrite (4) in the form

(a)   (b)   (c)
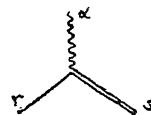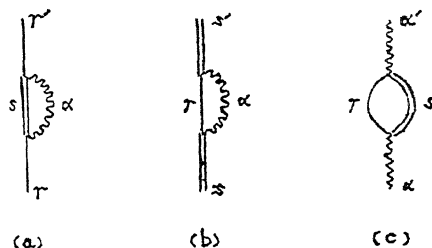
FIG. 2

FIGS. 1-2 Fig. 1. The primitive vertex. Fig. 2. The second order diagrams.

$$\sum_{a} g^{a}\,g^{+a} = A_{1}\,\mathbf{1} \qquad (5\,a)$$

$$\sum_{a} g^{+a}\,g^{a} = B_{1}\,\mathbf{1} \qquad (5\,b)$$

$$tr\,(g^{-a}\,g_{a'}{}^{+}) = C_{1}\,\delta_{aa'} \qquad (5\,c)$$

It is to be noticed that the unit matrices in (5 a) and (5 b) are respectively $m \times m$ and $n \times n$.

To proceed further we must appeal to a diagrammatic expansion of the propagator. Such an expansion follows most naturally in a perturbation theory : there are, however, some grounds for believing that the higher order relations derived by equating these quantities to have a large range of validity than perturbation theory itself. In the general case,[5] when no two of the multiplets E, F, ϕ are identical the next irreducible contribution to the propagator comes from a sixth order diagram (Fig. 3). These take the form :

$$\sum_{a\beta\gamma} g^{a}\,g^{+\beta}\,g^{\gamma}\,g^{+a}\,g^{\beta}\,g^{+\gamma} = A_{3}\,\mathbf{1} \qquad (6\,a)$$

$$\sum_{a\beta\gamma} g^{+a}\,g^{\beta}\,g^{+\gamma}\,g^{a}\,g^{+\beta}\,g^{\gamma} = B_{3}\,\mathbf{1} \qquad (6\,b)$$

$$\sum_{\beta\gamma} tr\,(g^{a}\,g^{+\beta}\,g^{\gamma}\,g^{+a}\,g^{\beta}\,g^{+\gamma} = C_{2}\,\delta_{aa'} \qquad (6\,c)$$

There are tenth, fourteenth,...order relations generalizing this structure. The constants A, B, C in these equations are not independent; they are related by

$$m\,A_{1} = n\,B_{1} = \nu\,C_{1} \qquad (5')$$

$$m\,A_{3} = n\,B_{3} = \nu\,C_{3} \qquad (6')$$
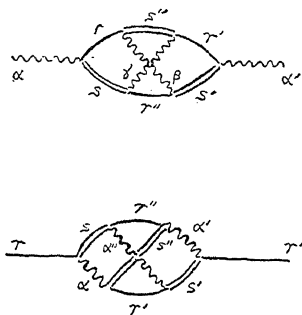
FIG. 3

FIG. 3. The sixth order diagrams.

and so on. All these equations including (5) are invariant under the automorphism

$$g^\alpha \to \sum_{\alpha'} V_{\alpha\alpha'} \, U \, g^{\alpha'} \, W^+ \qquad (7)$$

Considerable simplifications result if two of the mutiplets are the same, say $E = F$. In this case,[4] we could choose ϕ to be hermitian without any essential loss of generality. This implies that the coupling matrices g^α could be chosen hermitian so that we could drop the hermitian conjugation sign in these equations; (5 a) and (5 b) are no longer independent, and similarly

(a)   (b)
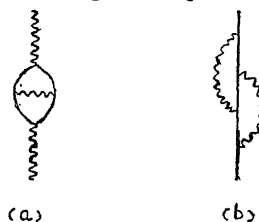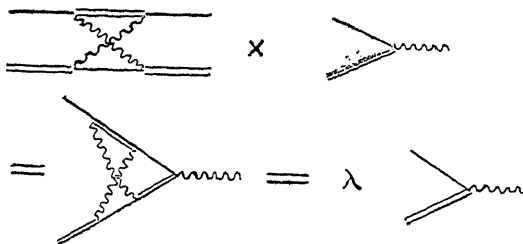
FIG. 4

FIG. 5

FIGS. 4–5. Fig. 4. The fourth order diagrams. Fig. 5. Diagram illustrating the self-consistency relation—Eq. (14).

(6 a) and (6 b). In addition, there are irreducible diagrams of fourth order, eighth order, etc. The fourth order diagrams (Fig. 4) give the contributions

$$\sum_{\alpha\beta} g^\alpha \, g^\beta \, g^\alpha \, g^\beta = A_2 \, \mathbf{1} \qquad (8)$$

$$\sum_{\beta} tr \, (g^\alpha g^\beta g^{\alpha'} g^\beta) = C_2 \, \delta_{\alpha\alpha'} \quad \frac{n A_2}{\nu} \delta_{\alpha\alpha'}. \qquad (9)$$

These relations are not, in general, invariant under the automorphisms (7) but only under the restricted automorphisms

$$g^\alpha \to \sum_{\alpha'} V_{\alpha\alpha'} \, U \, g^{\alpha'} \, U^+. \qquad (10)$$

We shall refer to the relations satisfied by the coupling matrices in either case as the Smushkevich relations.[4]

3. Smushkevich Equations from Self-consistent Dynamics

Essentially the same relations can be deduced from the self-consistent dynamical model. In this case, the interaction potential (or the N function of an N/D method) is due to the exchange of particles in the crossed channel, while the wave function of, say, the ϕ particle viewed as being composed of an E particle and an $\overline{F}$ particle (an F antiparticle) is to be considered an eigenfunction of this potential (corresponding to a low-lying bound state). Equality of the masses within a multiplet enables us to factorize the wave function[6] in a manner completely analogous to (3):

$$\psi^{\alpha)}_{(r,\,s)} = g^\alpha_{rs} \, \psi \qquad (11)$$

where ψ is a suitable function of momentum variables but independent of α, r, s. Normalization of the various components of ψ in (11) demands :

$$\sum_{s\,s} g^\alpha_{rs} \, (g^\alpha_{rs'})^* \, |\psi|^2 = \delta_{\alpha\alpha'}$$

which is equivalent to (4 c) with $C_1 = 1/|\psi|^2$. Similar relations follow from viewing an $E(\phi)$ particle as a bound state of an F particle and a $\phi(E)$ particle, thus completing the set of equations (4) or (5).

The potential is again defined in terms of the coupling constants g^α_{rs} introduced by (11). Again, two distinct cases arise depending upon whether we are considering two identical multiplets or all these multiplets being distinct. In the former case we have a one-particle exchange contribution to the potential, while in the second case the potential has only contributions corresponding to two (or four, six, eight, etc.) particle exchanges. Continuing to assume the degeneracy of the masses, we can write down the factorized forms

$$\sum_{\beta \gamma r'' s''} g^{\beta}{}_{rs''} (g^{\gamma}{}_{r' s''})^* g^{\gamma}{}_{r'' s} (g^{\beta}{}_{r'' s'})^* \cdot N$$
$$= \sum_{\beta \gamma} (g^{\beta} g^{\gamma +})_{rr'} (g^{\beta +} g^{\gamma})_{s' s} \cdot N \qquad (12)$$

for the scattering of an E particle and an $\overline{\mathrm{F}}$ particle (an F antiparticle). The requirement (see Fig. 5) that (11) is an eigenfunction of (12) leads to the relation[5]

$$\sum_{\beta \gamma r' s'} (g^{\beta} g^{\gamma +})_{rr'} (g^{\beta +} g^{\gamma})_{s' s} g^{\alpha}{}_{r' r'} = \lambda_3 g^{\alpha}{}_{rs} \quad (13)$$

where λ_3 is a constant, since the D matrix is diagonal. This may be rewritten

$$\sum_{\beta \gamma} g^{\beta} g^{\gamma +} g^{\alpha} g^{\beta +} g^{\gamma} = \lambda_3 g^{\alpha}. \qquad (14)$$

By similar considerations of the wave function of the E and F particle in terms of the other two particles we get *exactly the same equation.* Combining (14) with (5) we can deduce (6) with the parameters satisfying (5') and (6') in the form

$$\frac{A_3}{A_1} = \frac{B_3}{B_1} = \frac{C_3}{C_1} = \lambda_3.$$

For the case of two multiplets being identical, we have a one-particle exchange potential of the form[6]

$$\sum_{\beta} g^{\beta}{}_{rr'} g^{\beta}{}_{s' s} N \qquad (15)$$

which (see Fig. 6) leads to

$$\sum_{\beta} g^{\beta} g^{\alpha} g^{\beta} = \lambda_2 g^{\alpha} \qquad (16)$$

which, in turn, leads to (8) and (9) with

$$\frac{A_2}{A_1} = \frac{C_2}{C_1} = \lambda_2.$$
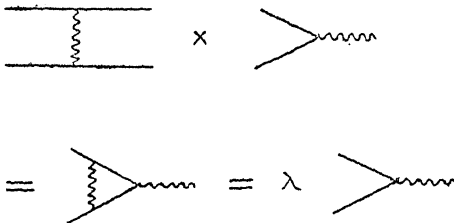
FIG. 6

FIG. 6. Diagram illustrating the derivation of Eq. (16).

This completes the derivation of the Smushkevich equations from dynamical considerations. We shall now seek the conditions under which the Smushkevich equations imply a symmetry group. We remark here that if the coupling constants transform as invariant three index symbols (generalized Clebsch-Gordan coefficients) then we know that these relations are all satisfied automatically, provided there

is only one unique invariant three index symbol (multiplicity-free coupling); the problem facing us is to determine the conditions under which the converse is true.

4. UNITARY SYMMETRY

The simplest case to consider is one in which $m = n = \sqrt{1 + \nu}$ but $E \neq F$. In this case, we can deduce SU_n symmetry[5] with E, F identified with the self-representations and ϕ with the adjoint representation of the group, making use of only (5) which follow, without the use of any diagrammatic expansion. To show this, we note that the matrices g^{α} which according to (5) satisfy the trace orthogonality

$$tr (g^{\alpha} g^{\alpha'+}) = A_1 \delta_{\alpha \alpha'} \quad 1 \leqslant \alpha, \alpha' \leqslant n^2 - 1 \quad (17)$$

can be augmented by a matrix g^0 which satisfies

$$tr(g^0 g^{\mu +}) = A_1 \delta_{3\mu} \quad 0 \leqslant \mu \leqslant n^2 - 1 \quad (18)$$

These n^2 matrices constitute a complete set of $n \times n$ matrices and, hence, satisfy the completeness relation

$$\sum_{\mu=0}^{n^2-1} g^{\mu}{}_{rs} (g^{\mu}{}_{r's'})^* = a \, \delta_{rr'} \delta_{ss'} \qquad (19)$$

where a is a suitable constant. Hence, in particular

$$\sum_{\mu=0}^{n^2-1} g^{\mu} g^{\mu +} = a \, \mathbf{1}$$

But we had, from (5),

$$\sum_{\alpha=1}^{n^2-1} g^{\alpha} g^{\alpha +} = \left(n - \frac{1}{n} \right) A_1 \mathbf{1}$$

This implies

$$g^0 g^{0+} = \left\{ a - A_1 \left(n - \frac{1}{n} \right) \right\} \mathbf{1}$$

so that g^0 is a multiple of a unitary matrix. We now make use of redefinition (2) of the particles of the multiplet which generates an automorphism of the type (7). If we now choose

$$U = \mathbf{1}, \quad W = \sqrt{\frac{n}{na + (n^2 - 1) A_1}} \; g^0 \qquad (20)$$

then it follows that

$$g^{\alpha} \to \sum_{\alpha'} V_{\alpha \alpha'} g^{\alpha'} W^+ \qquad (21)$$

with

$$tr (g^{\alpha}) \to \sum_{\alpha'} V_{\alpha \alpha'} tr (g^{\alpha'} W^+) = 0$$

according to (18) and (20). But $(n^2 - 1)$ traceless matrices satisfying (18) can be chosen to be proportional to the $(n^2 - 1)$ generators of SU_n in the $n \times n$ representation. We have thus deduced the SU_n invariance of the system with E, F transforming as the n dimensional representations of the group and ϕ transforming as the $(n^2 - 1)$ dimensional adjoint representa-

tion. Once we have deduced the group structure we can be assured that the higher order equations like (6) are automatically satisfied.

For the case of $E = F$, $m = n = \sqrt{1 + \nu}$ the derivation of unitary symmetry[4] is more complicated since the automorphisms (10) do not allow the transformation of the type (20). To prove tracelessness, one has to use the fourth order equations. We use (9) and (5) to deduce

$$\sum_{\beta} tr \{[g^\alpha, g^\beta] [g^{\alpha'}, g^\beta]\}$$
$$= 2\frac{i}{3}(C_2 - A_1 C_1) \delta_{\alpha\alpha'}.$$

From this equation, making use of the automorphisms (10) it is possible to show that the g^α must be traceless and, hence, that the interaction is invariant under SU_n with the multiplet $E = F$ and ϕ transforming as the n dimensional self-representation and the $(n^2 - 1)$ dimensional adjoint representation respectively.

These results are of interest in connection with the recent interest in the existence of particles belonging to the three-dimensional representation of SU_3 and the possible role of these particles in the realization of SU_3 as the relevant symmetry group. The models found here, in so far as the coupling of these "quarks" with octets is concerned, are similar to the constructions[7] of Zweig and of Gell-Mann for the $E = F$ case and to the construction of Bacry, Nuyts and Van Hove for the $E \neq F$ case.

We must emphasize here that the derivation of unitary symmetry from the Smushkevich equations in these two cases involved the assumption neither of isotopic spin conservation nor of the electric charge. With proper identification of the generators, we *deduce the conservation of isospin and of electric charge.*[4]

5. OCTET-OCTET-OCTET COUPLING

Another case of practical interest is the coupling of two identical octets with another octet in accordance with SU_3. In this case, the Smushkevich equations by themselves cannot yield the SU_3 invariant coupling. But if we assume that all three multiplets are the same and if their coupling matrices are completely antisymmetric (appropriate, for example, for the "gauge" coupling of vector mesons), we can deduce[8] that the coupling constants constitute the structure constants of some semi-simple Lie group with the particles transforming as the adjoint representation; if we further restrict the set of particles to be irreducible (*i.e.*, cannot be separated into mutually non-interacting sub-multiplets), it must be a simple Lie group. If we now seek the solution corresponding to $n = 8$, we can single out the simple group SU_3. Hence,

a completely antisymmetric trilinear coupling of an octet must be SU_3 invariant[9] as a consequence of the Smushkevich equations.

Instead of requiring complete antisymmetry, we may substitute other requirements. For example, by requiring conservation of isospin and hypercharge as well as charge conjugation invariance in the coupling of two (pseudoscalar) octets with a (vector) octet we can again derive unitary symmetry for their coupling.

6. NON-RELATIVISTIC MODELS; SU_6

So far, our discussion was carried out in a manner appropriate to a relativistic theory. But the notion of symmetry, the particle exchange mechanism of generating forces and the notion of antiparticles, etc., are not restricted to a relativistic theory. We can, for example, consider a Galilei invariant theory (or even a Euclidean theory); in this case, the particle-antiparticle correspondence is not inevitable but is consistent with Galilei or Euclidean invariance.[11] By a parallel development, we can again deduce the self-consistency equations (14) and (16) for the self-consistent dynamical Smushkevich equations.

In the case of the Galilei group, the spin is a more or less independent quantity; and it is possible to consider special kinds of interaction in which the spin is conserved by itself. By a natural generalization, it is possible to consider a theory in which we form multiplets in which the multiplet labels may include the spin labels. We can then again deduce, for the $m = n = (1 + \nu)^{\frac{1}{2}}$ case a unitary symmetry scheme. Thus, using a triplet of spin half particles for the $E = F$ multiplet, we can deduce SU_6 invariance in the interaction of these particles with a 35-component boson multiplet.[12] Since the SU_6 transformations treat the spin and the additional particle label on the same footing, the 35-component multiplet will contain particles with different spins. Gürsey, Radicati and Pais, and Sakita have shown[12] that in such a scheme, the 35-component multiplet breaks up into a pseudoscalar (scalar) octet and a vector (pseudovector) nonet. The baryon supermultiplet corresponding to the third rank symmetric tensor has 56 components, and breaks up into a $1/2+$ baryon octet and a $3/2+$ baryon resonance decuplet. (Incidentally, the Thomas term arising as a relativistic correction, or any other spin-orbit force produces automatically a breakdown of this SU_6 symmetry.)

7. BROKEN SYMMETRY

The particles in nature do not fall into mass degenerate super-multiplets, the masses are only

approximately equal. It is true that the mass deviations from the unitary symmetric limit can be quantitatively understood in terms of a simple mass formula. But the question arises as to how such perturbations of symmetry can be reconciled with the dynamical scheme we have been considering. There are two possible ways in which this can arise : first, the mass deviations that are observed destroy the factorizability of the potential, wave function, or the propagator contributions ; the problem can then no longer be studied as an algebraic problem. The other mechanism of symmetry breakdown is to have all the Smushkevich equations satisfied and yet the solutions not exhibiting a group structure[5] ; this feature of the solutions of field equations was emphasized already by Heisenberg in connection with his theory of elementary particles. The general symmetry violation is composed of both kinds.

The symmetry violations of the second type have been studied only in the special case $m = n = 3$; $E = F \neq \phi$. In this case, one finds[5] three solutions : one corresponding to invariance under SU_2 ; another one corresponding to a 3-parameter Abelian group (this is a reducible case) ; and a third case in which there is no continuous symmetry group, but all the Smushkevich equations are satisfied. Clearly more work is needed to understand these cases. But it appears that for the equal mass case these violations of the symmetry are always large. This is to be contrasted with the case of the first type of symmetry violation where the deviation could be as small as we like.

In case the mass degeneracy within a multiplet is split by small amounts, we can study the modifications in a self-consistent theory by considering the deviations as expanded in terms of quantities transforming irreducibly under the symmetry group.[6] If the coupling transforms as an invariant *plus* a small term transforming as an irreducible representation, then the Smushkevich equations (5) and (6) have their right-hand sides replaced by matrices transforming as this irreducible representation. The equations so obtained may not fully specify the deviations of the coupling from its unitary symmetry limit. In the self-consistent dynamical model the corresponding modification is to alter the self-consistency relations (14) and (16) by having a "small" arbitrary linear combination of matrices G^α which transform as the specific irreducible representation added to the matrix g^α on the right-hand side. The structure and stability of this system has not been investigated in any great detail; but it is possible to

have some kind of symmetry violations preferred over other kinds.

There have been a variety of attempts to understand the apparent breakdown of the higher symmetries, say SU_3, in terms of a lack of commutability of the Lorentz group and internal symmetry group.[13] But to-date, the results have been disappointing in that within a reasonable purely group-theoretic scheme of non-commutability it seems[14] impossible to break the symmetry.

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LETTERS TO THE EDITOR

SOME ARITHMETICAL PROPERTIES OF THE FOURIER COEFFICIENTS OF THE MODULAR INVARIANT $j(\tau)$

THE arithmetical properties of the Fourier coefficients $c(n)$ of $j(\tau)$, the classical modular invariant of Klein, have been the subject of investigation by several authors. Some of the more important results obtained by Lehner, Newman, and Kolberg have been collected together in a recently published book by Lehner.[1] The present writer has obtained a number of new results, some of which are given below.

If p stands for any of the primes 2, 3, 5 and 7, then

$$c(pn) \equiv -p^u n^v \sigma_k(n) \pmod{p^w},$$

where p, u, v, w, k stand for any of the following four sets of values :

(i) 2, 11, 3, 15, 1 ;   (ii) 3, 5, 2, 7, 1 ;

(iii) 5, 2, 1, 3, 1 ; and (iv) 7, 1, 1, 2, 3 ;

$\sigma_k(n)$ being, as usual, the sum of the k-th powers of the divisors of n. [This result can be generalised to cover $c(p^\lambda n)$, λ being a positive integer.]

Another result is that, if a, b, c, d are non-negative integers and

$$n \equiv 0 \pmod{2^a 3^b 5^c 7^d}, n > 0,$$

then

$$c(n) \equiv 0 \pmod{2^{3a+12} \, 3^{2b+5} \, 5^{c+2} \, 7^{d+1}} \quad (1)$$

for "almost all" such values of n. It is interesting to compare this result with the one established by Lehner, viz.,

$$c(n) \equiv 0 \pmod{2^{3a+8} \, 3^{2b+3} \, 5^{c+1} \, 7^d} \quad (2)$$

for all such n's. [It is understood that if one or more of the primes 2, 3, 5, 7 are not divisors of n then the corresponding prime powers are to be removed from the moduli in the congruences (1) and (2) for $c(n)$].

As illustration of another type of result we have the following. The least (positive) residue of $c(7^{6d+4})$ to the modulus 7^{6d+5} is 7^{6d+4}. There are similar results for other exponents, and also for the primes 2, 3 and 5.

Again, there are results of the type

$$c[2^a (4n+3)] \equiv 0 \pmod{2^{3a+10}}, a > 0.$$

All these and other results will be published elsewhere with necessary proofs.

Dept. of National Sample Survey,   D. B. LAHIRI.
Indian Statistical Institute,
Calcutta-35, *February* 8, 1965.

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EFFECT OF DISSOCIATION ON THE HYPERSONIC FLOW PAST A WEDGE

NATH[1] has obtained the various characteristics of the hypersonic flow past a wedge at zero angle of incidence with attached shock without dissociation and viscosity. Following the notation of Ref. 1, the effect of dissociation on the various characteristics of the flow is considered in the present note.

The equation governing the flow characteristics in the shock layer is the same as in Ref. 1. The equilibrium conditions across the shock are determined by means of correlation equations developed by Waiter and Choudhury.[2] The density, pressure, temperature and enthalpy across the shock are given by

$$\frac{\rho_1}{\rho_\psi} = k = 0.1 \quad (1)$$

$$\frac{p_\psi}{p_1} = 1.27 m^2 \sin^2\psi \quad (2)$$

$$\frac{\gamma}{\gamma_1} \frac{a^2\psi}{a_1^2} = \frac{m}{m_1} \frac{T_\psi}{T_1} = 0.127 m^2 \sin^2\psi \quad (3)$$

$$\frac{h_\psi}{h_1} = 1 + 0.2 m^2 \sin^2\psi \quad (4)$$

where γ_1 and m_1 are respectively effective ratio of specific heats and effective molecular weight of air just behind the shock in the presence of dissociation and can be obtained from tables of the thermodynamic properties of air.[3] The angle ψ is given by

$$K \tan\psi = \tan(\psi - a) \quad (5)$$

ψ is almost constant for all Mach number for which dissociation occurs when a is constant. γ_1 and m_1 are considered to be constant in the shock layer.

The velocity in the shock layer is given by the same expression as in Ref. 1, but ψ should be determined from (5). The density, pressure, temperature, velocity of sound and enthalpy are constant in the shock layer and are given by equations (1) to (4). The Mach number and

pressure coefficient are also constant in the shock layer and are respectively given by :

$$M_\theta{}^2 = \cfrac{1}{\cfrac{\gamma_1}{\gamma} \, 0\cdot127 \sin^2\psi} \cdot \frac{\cos^2\psi}{\cos^2(\psi - a)} \qquad (6)$$

$$C_p = \frac{2}{\gamma m^2} [1\cdot27 m^2 \sin^2\psi - 1]. \qquad (7)$$

The pressure, pressure coefficient, temperature, enthalpy and shock wave angle ψ decrease due to dissociation. The pressure gradient vanishes on the surface.

Thököly u'+ 82,   GIRISHWAR NATH.*
Budapest XIV, Hungary,
September 22, 1964.

* Permanent address : Science College, Patna University, Patna-5 (Bihar), India.

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NUCLEAR SHELL NUMBERS IN LIGHT ELEMENTS

THE optical model of the nucleus, proposed by Fernbach, Serber and Taylor,[1] have been used to account for the nuclear scattering of nucleons at various energies. Such a model is defined by a certain nuclear density distribution $\rho(\bar{r})$ and a complex refractive index 'n' written as

$$n = 1 + \cfrac{\left(\overline{k_1} + i \dfrac{\overline{K}}{2} \right) \rho(\bar{r})}{k} \qquad (1)$$

$$= 1 + \bar{n} \, \rho(\bar{r})$$

where k_1 and $\overline{K}$ are independent parameters defined as

$$\overline{k_1} = \frac{\pi \{f_{nn}(0) + f_{np}(0)\}}{k}$$

$$\overline{K} = \left(\frac{\pi}{k} \right) \{\sigma_{np} + \sigma_{nn}\}$$

and

$$k = \left(\frac{E^2 - M_0{}^2 C^4}{\hbar C} \right)^{\frac{1}{2}},$$

where $f_{nn}(0)$, $f_{np}(0)$ are the forward scattering amplitudes for (n, n) and (n, p) scattering respectively, σ_{nn}, σ_{np} are the scattering cross-sections for (n, n) and (n, p) scattering respectively and ϵ is the exclusion factor.

In the present investigation we have used the radial distribution method followed by Gatha and Shah[2] and determined a characteristic nuclear density distribution based on the ana-

lysis of the data on the elastic scattering of 180 MeV protons from light nuclei up to Aluminium. Since the available experimental data on the nuclear scattering of 180 MeV protons has been obtained for $\theta > 5°$ and since the coulomb effects are entirely insignificant in this region for light elements we have taken these data to represent the nuclear scattering of 180 MeV nucleons in general. The characteristic angular distribution curve is fitted by two Gaussians neglecting the maxima and minima. This is represented by the expression

$$g(\overline{S}) = a_1 \exp(-b_1 \overline{S}^2)$$
$$+ a_2 \exp(-b_2 \overline{S}^2) \qquad (2)$$

where

$$a_1 = 0\cdot08 \times 10^{-13} \text{ cm.,}$$
$$a_2 = 0\cdot58 \times 10^{-13} \text{ cm.,}$$
$$b_1 = 0\cdot068 \times 10^{-26} \text{ cm.}^2,$$
$$b_2 = 0\cdot41 \times 10^{-26} \text{ cm}^2.$$

The corresponding characteristic nuclear density distribution obtained by the method of Gatha and Shah[2] is represented by

$$\rho(\bar{r}) = N \{a_1 \exp(-\beta_1 r^2)$$
$$+ a_2 \exp(-\beta_2 \bar{r}^2)\} \qquad (3)$$

where

$$a_1 = 1\cdot98 \times 10^{26} \text{ cm.}^{-2},$$
$$a_2 = 0\cdot96 \times 10^{26} \text{ cm.}^{-2},$$
$$\beta_1 = 3\cdot65 \times 10^{26} \text{ cm.}^{-2},$$
$$\beta_2 = 0\cdot61 \times 10^{26} \text{ cm.}^{-2},$$

and

$$N = 0\cdot77 \times 10^{13} \text{ cm.}^{-1}$$

The normalisation factor N in the nuclear density distribution is given by

$$N = \frac{\hbar^2 E}{\pi M_0 \, |\, \bar{n}\,| \, (E^2 - M_0{}^2 C^4)}.$$

Substituting the value of N in the above expression we get

$$\bar{n} = 5\cdot16 \times 10^{-40} \text{ cm.}^3$$

At 180 MeV, $k = 3\cdot08 \times 10^{-13}$ cm.[1] which gives

$$\overline{k_1}^2 + \frac{\overline{K}^2}{4} = 253 \times 10^{-54} \text{ cm.}^4$$

Using the experimental values of scattering cross-sections at this energy, *viz.*,

$$\sigma_{nn} = 42\cdot8 \text{ mbn,} \qquad \sigma_{np} = 22\cdot7 \text{ mbn,}$$

and taking $\epsilon = 0\cdot5$, we get $\overline{K} = 16\cdot38$ mbn which leads to $\overline{k_1} = 13\cdot64$ mbn. This value of $\overline{k_1}$ agrees with the value of 15 mbn as obtained from the hard core nucleon model of Jastrow.[4]

We have tested the validity of this nuclear density distribution proposed by us from the point of view of nuclear shell numbers. On the basis of Thomos-Fermi nuclear model a corelation has been established by Born and Yang[5] and Yang[6] between the nuclear density distribution and the nuclear shell numbers. The number of neutrons or protons in the completed shell characterised by the angular momentum is given by

$$N_l = \frac{\left(l + \frac{3}{2}\right)^3}{3\pi^2 \, \bar{r}_m^3 \, \rho \, (\bar{r}_m)} \qquad (4)$$

where $\bar{r}_m$ = the value of $\bar{r}$ when $\bar{r}^3\rho(\bar{r})$ is maximum and $\rho(\bar{r}_m)$, the nuclear density at $(\bar{r}_m)$. The calculated values of the nuclear shell numbers together with empirically obtained values are given in Table I.

TABLE I

l	0	1	2	3	4
N_l (empirical) ..	2	8	20	50	82
N_l (calculated) ..	1·8	8·2	22·4	47·6	86·9

This shows that the nuclear density distribution as determined above is fairly consistent with this requirement.

Physics Department,　　　　　R. H. N. Iyer.
Bhavan's College,　　　　　　G. Z. Shah.
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SYNTHESIS OF PRUDOMESTIN

In an earlier publication Nagarajan and Seshadri[1] described the isolation and study of prudomestin obtained from the heart-wood cf *Prunus domestica*. It was given the constitution (I) based on spectral data, degradation reactions and comparison of the partial ethyl ether (II) with a synthetic sample. The synthesis of prudomestin could not be achieved as the partial demethylation at the 5-position of 3, 7-dihydroxy-5, 8, 4'-trimethoxyflavone (III) was unsuccessful.

In the course of a systematic study of other methods it has been found that oxidative demethylation with nitric acid could be used for the required synthesis. It has been employed earlier for the synthesis of isowogonin (IV)[2] from 5, 7, 8-trimethoxyflavone (V), the intermediate flavoquinone (VI) being reduced with sodium sulphite in acetic acid. Several other applications of this method are known.[3]
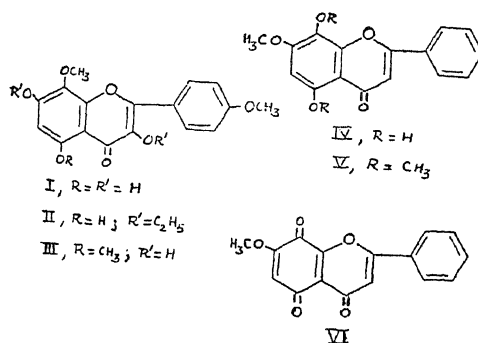
CHART 1

The synthesis of prudomestin (I) has been accomplished starting from the flavonol (III). This was first benzylated and the dibenzyl ether (VII) was oxidised with nitric acid to the flavoquinone (VIII). The deep red flavoquinone dissolved readily in aqueous sodium hydroxide forming a bluish-violet solution. It was smoothly reduced to the yellow quinol (IX) with sodium sulphite in acetic acid. The quinol answered the gossypetone test,[4] gave a transient green colour changing to brown with ferric chloride and dissolved in aqueous sodium hydroxide to give a yellow solution. Partial methylation of the quinol gave the expected 8-O-methyl ether (X) which yielded prudomestin on catalytic debenzylation. The synthetic sample was identical with the natural one in all respects. In exploratory experiments using the flavonol (XI), the lower member, 3, 5, 7-trihydroxy-8-methoxyflavone (XII), has also been synthesised. The details are under publication.
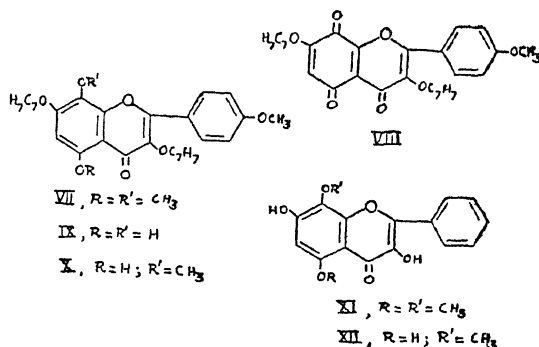
CHART 2

Department of Chemistry,   M. KRISHNAMURTI.
University of Delhi,   T. R. SESHADRI.
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AMINO-ACIDS OF MALE AND FEMALE FLOWERS OF PAPAYA

DIFFERENT species of plants often show marked variations in their chemical components such as amino-acids, alcohols, phenols, etc. This knowledge is being increasingly used in attempts to evolve new methods of plant classification and is leading to a new scientific discipline combining biochemistry and orthodox plant taxonomy into what is now termed as plant biochemical systematics.[1] Furthermore, differences in the free amino-acid patterns seem to exist even between male and female plants of the same species.[2] The present investigation has been undertaken to determine the differences, if any, in the free amino-acids in the male and female flowers of papaya (*Carica papaya* L.), which bear male and female flowers on different plants.

The male and female flowers of papaya were collected in the morning (10·00 to 11·00 a.m.) and fixed in 80% alcohol and extracts of free amino-acids were prepared immediately. The identification of amino-acids was done by means of circular, ascending, descending and two-dimensional chromatography, using Whatman filter-paper No. 1 in different solvent systems and 0·5% ninhydrin in acetone for the development of colour. By visual comparison of the colour intensity of the spots, assessment was made of the amount of different amino-acids present in the samples. The results obtained are presented in Table I.

The results show that both male and female flowers of papaya contain the same 13 free amino-acids, while methionine cannot be detected in both kinds of flowers. In this respect, our findings corroborate the results earlier obtained by Rangaswami[2] while working with another diœcious plant, *viz.*, *Coccinea indica* L.

It is further seen that in female flowers of papaya, asparagine is present in fairly greater amounts than in male flowers, while the free acid concentration is the reverse. However, the overall concentration of aspartic acid and its amine are greater in female than in male papaya flowers. Similar results were obtained by Rangaswami[2] with *Coccinea indica* plant. But in the case of papaya plant slight increase of alanine levels in male than female were found, in contrast to *Coccinea indica*.

TABLE I

	Amino-acids		Female flower	Male flower
1	Leucine	..	+	+
2	Iso leucine	..	trace	trace
3	Phenyl alanine	..	trace	trace
4	Valine	..	+	+
5	Alanine	..	+	+ +
6	Tyrosine	..	+	+
7	Threonine	..	+	+
8	Aspartic acid	..	+	+ +
9	Asparagine	..	+ + +	+
10	Arinine	..	+ + + +	+
11	Histidine	..	+ + +	+
12	Lysine	..	+	+
13	Cystine	..	+	+

Each + sign indicates about 2 mg./100 gms. of flower.

Strangely enough, glutamic acid or its amine is absent in papaya; the cause of this needs investigation. Further, histidine and arginine are present in significantly greater amounts in female than in male flowers. Thus, there seems to be preferential accumulation of some acidic and basic amino-acids in female flowers of papaya, compared with the male flowers.

Jawaharlal Institute of   S. KASINATHAN.
Postgraduate Medical   S. RAMAKRISHNAN.
Education and Research   B. SRINIVASAN.
and Dhanvantari Medical College,
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EFFECT OF ENOVID ON THE LIPID CONSTITUENTS OF THE RHESUS MONKEY PITUITARY

IN connection with the widespread use of enovid in long-term cyclic ovulation control concern has been expressed about its possible harmful effects on the pituitary.[1,2] Prolonged administration of this steroid has been reported to cause an enlargement of the pituitary of rats and an increase in the amount of chromophobe tissue.[2] As steroids are known to exert a marked influence on lipid metabolism,[3] it seemed worthwhile to investigate the effect of enovid on the lipid constituents of the rhesus monkey pituitary.

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TABLE I

*Effect of enovid on the lipid constituents of the rhesus monkey pituitary**

Status	Total lipids (% of dry weight)	Sterol esters (% of total lipids)	Free sterols (% of total lipids)	Phospholipid (% of total lipids)	Phospholipid bases (% of total phospholipids)		
					Choline	Serine	Ethanolamine
Controls (solvent only) ..	1·24	45·32	19·44	7·58	31·23	6·75	20·42
Enovid ..	1·27	45·43	19·55	7·67	31·24	6·72	20·45

* Data based on pooled pituitary from 3 monkeys per group. Each datum represents the mean of 3 estimations.

Immature female rhesus monkeys (*Macaca mulatta*), 120–50 days old and weighing 1·5–1·8 kg., received enovid (dissolved in olive oil) daily by the oral route for 180 days. The dose was 5 mg. [4·925 mg. 17 α-ethynyl-17 hydroxy-5 (10)-estren-3-one + 0·075 mg. 17 α-ethynylestradiol-3-methyl ether] per animal. The control animals received the solvent alone in a similar manner. The lipids were estimated by methods employed in a previous study.[3] The total gonadotrophin content of the pituitary was assayed by the immature mice uterine weight response.[4]

The weight and total gonadotrophin content of the pituitary did not register any change after 180 days of continuous enovid treatment. It was to be noted that the pituitary of these immature monkeys was virtually devoid of gonadotrophin. From the data presented in Table I it will be evident that the steroid had also no appreciable effect on the lipid constituents of the pituitary. It is significant that the present dose of enovid is employed cyclically in women for long-term ovulation-control *vis-a-vis* contraception.[5]

THE PROTEINS OF SOME PLANT LATEX

ALTHOUGH the importance of proteins in the chemistry and technology of latex and raw rubber has long been recognized it is only recently that experimental evidence has been forwarded in its support. Skinner and Drakeley[1] have reported that proteins play an important rôle in the water absorption of raw rubber whereas Davis and Blake[2] claim that they exert a considerable influence on their vulcanizing properties. Bondy and Freundlich[3] and Kemp and Straitiff[4] demonstrated the presence of three protein fractions in freshly prepared as well as ammonia-preserved latex sera of *Hevea brasiliensis* though the presence of ammonia in the latter brought about some changes in the composition and properties of the proteins. According to Altman[5] the fresh un-ammoniated latex contains about 1% of proteins part of which is adsorbed at the surface of the rubber particles while the remainder is distributed between the aqueous serum phase of the latex and the lutoid bodies first described by Homans and Van Gils.[6] Presence of proteins in fresh latex has been claimed as an important factor which controls the colloidal stability and hence information

both qualitative and quantitative about the individual proteins with regard to their distribution in the above-mentioned three phases should be of help to understand the colloidal behaviour of latex.

Roe and Ewart made a detailed analysis of the proteins of unammoniated latex serum of *Hevea brasiliensis* electrophoretically and claimed in it the presence of seven distinct protein constituents. Archer and Sekhar[8] confirmed these findings and also showed that the properties and composition of the serum prepared by prolonged freezing of latex differed significantly from those of the serum obtained by centrifuging fresh latex.

Though the aqueous extracts of the sedimentable phase of *Hevea* latex ('bottom fraction') was shown to contain eight electrophoretic fractions by Moir and Tata[9] the same authors[10] have very recently reported that the 'C serum' prepared by high speed centrifugation of the latex after freeze-drying and re-dissolving at higher concentration on subjecting to starch gel electrophoresis could be resolved into not less than twenty-one distinct components.

In the absence of any such data similar to the above pertaining to the proteins of laticiferous plants in which India abounds, it was thought interesting to determine in the first place, the number of protein components of some latices available in appreciable quantities. The following describes the electrophoretic analysis of twelve samples of latex sera of plants belonging to different families and species.

MATERIALS AND METHODS

Latex was collected from several plants of the same species growing in the same locality by nipping the leaves near the stem and allowing the milk to drain in a clean beaker kept immersed in salt-ice mixture. Serum was obtained by freezing the latex at $-20°$ for a period of three weeks as described by Sekhar and McMullen.[11]

Electrophoresis was performed on an LKB 3276 model employing Michaelis' veronal buffer[12] of ionic concentration $1·25 \times 10^{-1}$ at pH 8·6. Sera (5–20 μL) were applied uniformly on Carl Schleicher and Schüll No. 2043 B (120 g./m.[2]) filter-paper strips (40 × 410 mm.). Four strips were run simultaneously for four hours though sometimes longer runs up to 16 hours were made with the voltage varying accordingly.

Amido black 10 B in excess to saturation in methanol, acetic acid and water (40 : 10 : 50, v./v.) was employed for dyeing the resolved proteins,
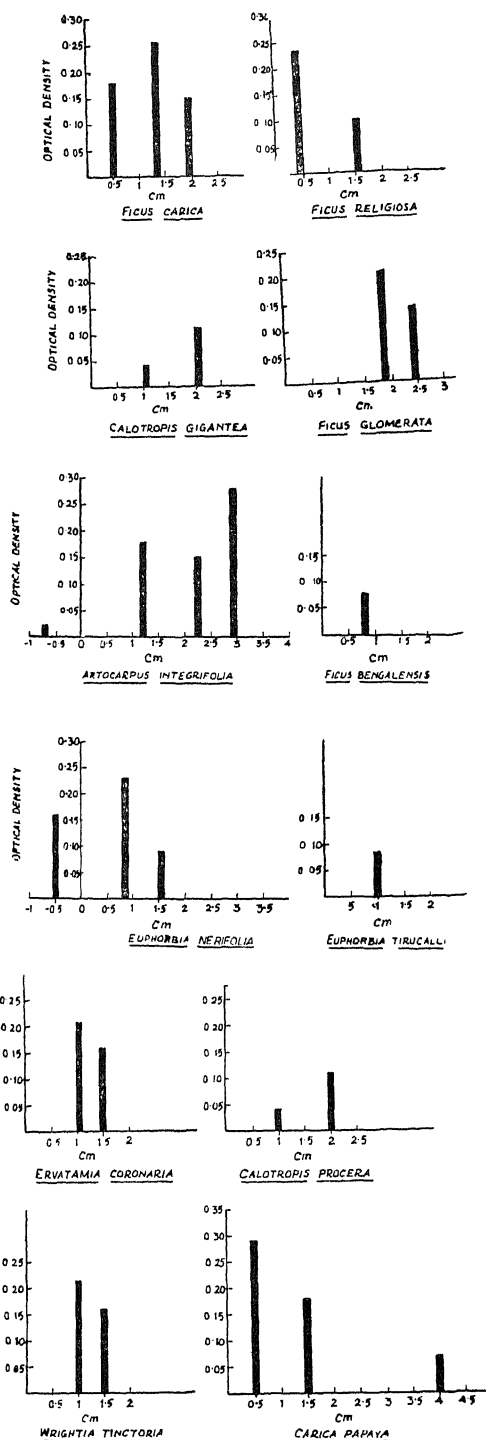
FIG. 1

EVALUATION OF THE PROTEIN COMPONENTS

When the proteins were fairly well resolved and each band could definitely be related to an electrophoretic component the paper was cut into pieces each containing only one component. The dye was then extracted by sodium carbonate solution (5%, w./v.) in methanol (50%, v./v.). The extract was diluted to a definite volume and the optical density of each component extract was measured in an SP 300 colorimeter. In cases, where the resolution of the proteins was not sharp the papers were cut into strips of equal width at right angles to the direction of migration. From the peaks observed the number of components of proteins in the samples was determined and represented diagrammatically (Fig. 1).

The results obtained suggest that the latex of *Artocarpus integrifolia* contains the maximum number of four proteins. On the other hand, the latices of *Carica papaya*, *Euphorbia nerifolia* and *Ficus carica* evince the presence of three proteins each whereas those of *Ficus glomerata*, *Ficus religiosa*, *Ervatamia coronaria*, *Wrightia tinctoria*, *Calotropis procera* and *Calotropis gigantea* show the presence of only two each. The latices of *Euphorbia tirucalli* and *Ficus bengalensis* seem to consist of one single protein.

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ORIGIN OF KATNI BAUXITE BY ALTERATION OF SEMRI SERIES

THE bauxite deposits of Katni (Lat. 23° 50′ N.; Long. 80° 24′ E.) cover an area of about 5 sq. km. It is interesting to note that no trace of altered or unaltered trap rocks exists in the Katni area, yet C. S. Fox[1] (1923) thought that these deposits may be an alteration product of Deccan Traps.

The bauxite deposits rest over interbedded limestone and shales of Semri Series (Lower Vindhyans). The authors have come to the conclusion that the Katni bauxite is most probably genetically related to clays or shales of Lower Vindhyan formations. This can be easily explained with the help of the generalised section of Flag Staff Hill of Katni in Fig. 1.
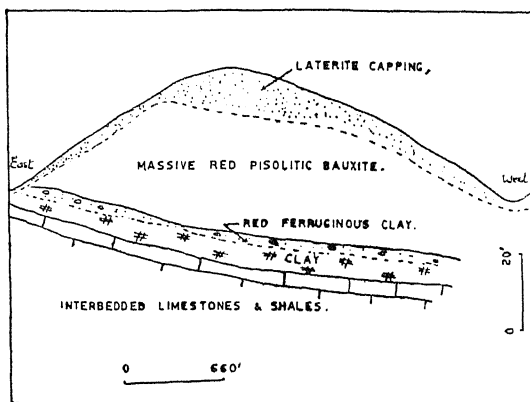
FIG. 1

The bedded nature of bauxite is well seen at village Tikuri, where the whole formation, bauxite as well as the underlying limestone and shale, shows a constant dip of 15° to 18° towards west. When the formations are traced laterally towards north or south, the bauxite occurs as discontinuous bands with the larger dimensions parallel to the regional strike direction. Such discontinuous bands of bauxite are surrounded by argillaceous and calcareous matrix, which invariably contain unaltered relics of limestone patches or chips. These limestone patches or chips show a marked regularity in their alignment parallel to the regional north-south strike direction.

The bauxite is pinkish to white, mottled with red or brown colour and is pisolitic. Pisolites, varying from pea to walnut sizes, are mainly composed of cliachite and boehmite. Cracks healed up by iron oxide or by chalcedony, are common in these pisolites. The matrix is composed of gibbsite and iron oxide. Brucite in the form of platy aggregates, partly replaced by

iron oxide, has been observed in the matrix of two thin sections of bauxite from Tikuri.

The authors are grateful to Dr. A. K. Bhattacharya and Dr. A. D. Kharakwal for their useful suggestions and help during the course of the work.

Department of Geology,   I. C. Pande.
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RELATION OF BASIC DIKES TO FLUORITE DEPOSITS AT CHANDIDONGRI, DURG DISTRICT, MADHYA PRADESH

During the course of field investigations around the Chandidongri fluorite mine, Durg District, M.P., the author came across some basic dikes which are closely associated with the fluorite deposits at and around Chandidongri. The fluorite deposits of this area occur as separate bodies within the Kotnapani fault (S. N. Sarkar). The country rock is coarse to porphyritic granite. Twelve basic dikes each up to 2 miles in length and 15 to 30 feet in thickness intrude into the granite. A few of them studied under microscope have been found to be dolerite to metadolerite in nature.

At Chandidongri, a dolerite dike having a strike of N 65° W comes in contact with the fluorite deposit towards the west. At this contact it has been deviated parallel to the ore vein for about 400'. On the eastern side it has again followed its original trend of strike. The following evidences prove that the dike is older than the ore :

(1) The dike is brecciated and fragments of the dike rocks are associated with the ore.

(2) The dike is mineralized with fluorite, quartz and galena in the form of narrow veins.

(3) The mineralizing solutions have reacted with the dike rock and have altered it into a green chloritized and silicified rock.

An outer zone of chloritization and kaolinization and an inner zone of sericitization associated with minor propilitization of the country rock are found around the deposit.

This type of rock alteration and structural relation are seen at Lamtidongri and Katnapani. It is obvious that the intersection of dikes and fault plane have provided excellent sites for ore deposition due to intensive brecciation. On the

basis of this study, seven localities have been located which are proposed for further prospecting (Map 1).
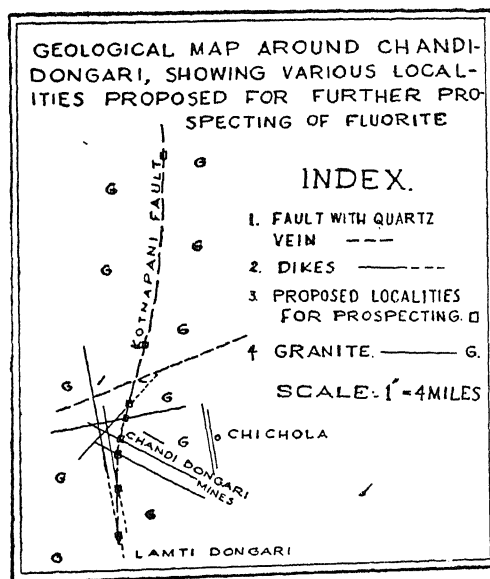
MAP 1

Dept. of Applied Geology,   M. Roy.
Govt. College of Engg. and Tech.,
Raipur (M.P.),
October 28, 1964.

OBSERVATIONS ON *MORANOCLADUS OLDHAMI* (ZEILLER)—AN APPRAISAL OF THE GENUS *MORANOCLADUS**

A specimen of coniferous shoot, collected by T. W. H. Hughes in 1877 from Morand valley in Madhya Pradesh, referred to as belonging to Lower Gondwanas was identified by Zeiller (1902) as *Araucarites oldhami*. While describing this new species Zeiller, however, remarked that the genus *Araucarites* was not known from Lower Gondwanas and that in fact he was not aware of its occurrence from formations below Jurassics. Seward and Sahni (1920) re-examined the specimen (G.S.I. Type No. 7180) and also noted the close resemblance of the shoot with that of Araucarias. However, they observed that "....in view of the age of the fossil and the absence of any Araucarian cone-scales from the same horizon, the generic name *Araucarites* implies excessive confidence in the significance of superficial resemblance. We therefore propose the new name, *Morania*". Later, Sahni (1928) changed the generic name to *Morano-*

cladus as the name *Morania* was already occupied.

The stratigraphic position of the rocks exposed along the Morand valley was not clearly understood from the beginning. J. G. Medlicott (1860) and W. T. Blanford (1869) considered them to be Damudas while H. B. Medlicott (1871) thought them to be either Damudas or possibly Mahadevas. In the above circumstances, Hughes' specimen was considered as belonging to the Lower Gondwanas. C. S. Fox (*see* Pascoe, 1926) also felt that these possibly belonged to the Barakars. But Crookshank (1936) has clearly shown that coal-bearing formations of Morand valley belong to the Upper Gondwanas and probably to Jabalpurs. His conclusions were based on the field relationship and the fossil contents of these beds.

The authors in 1964 examined the Gondwana formations of the Morand valley and made a good collection of fossil plants which includes the already known forms such as : *Ptilophyllum acutifolium*, *P. cutchense*, *Desmiophyllum indicum*, *Elatocladus* sp. and *Araucarites cutchensis*. The new fossils are : Equisetaceous stem, *Sphenopteris* cf. *arcuta*, *Dicksonia* sp., *Bucklandia* sp., *Dictyozamites* sp., *Zamites indicus* sp. nov., ? *Nilssonia* sp., ? *Ctenis* sp., *Elatocladus jabalpurensis*, *E.* (? *Torreyites*) sp., *Retinosporites indica* and *Brachyphyllum* cf. *rhombicum*. The assemblage clearly indicates a Jabalpur age to these beds. It is observed that no Lower Gondwana rocks are seen in the Morand valley.

The authors also have examined the original specimen identified by Zeiller and feel that it has a close resemblance to Araucarias.

In view of the above stratigraphical and palæobotanical considerations, it is evident that this specimen came definitely from the Upper Gondwanas and not from the Lower. Hence it is necessary to drop the name *Moranocladus* and to reinstate the name *Araucarites* to this specimen. Thus the revision will remove the confusion existing at present regarding the occurrence of this conifer from the Lower Gondwanas of India.

The present position of the specimen can be mentioned as follows:

Araucarites oldhami Zeiller, 1902
    Morania oldhami Seward and Sahni, 1920 ;
    Moranocladus oldhami Sahni, 1928.

Locality—Morand River.

Horizon—Jabalpurs, Upper Gondwanas (Upper Jurassic).

The authors are thankful to Shri M. V. A. Sastry for his suggestions in the above work.

Central Palæontological Labs.,   S. C. SHAH.
Geological Survey of India,   GOPAL SINGH.
Calcutta, *September* 30, 1964.

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A *AGASSIZOCRINUS* FROM THE SYRINGOTHYRIS LIMESTONE OF KASHMIR

THIS note records the occurrence of *Agassizocrinus* from the Syringothyris limestone of Kashmir. Only one specimen of a well-preserved calyx was collected from the Syringothyris limestone exposed in the Kotsu Hill (33° 51′ 30″ : 75° 18′ 00″). The calyx was collected by the author during the field season 1964 (April–June).

Though calyces of *Agassizocrinus* are common in the Kaskaskia to Coal Measure formations of Europe and Mississipian to Chester formations of America, the present specimen constitutes the first record of this genus from the Lower Carboniferous and for that matter, from the Palæozoic formations of India.

The calyx (Fig. 1) under description is pyriform, arms uniserial, infrabasals fused into one hemispherical plate and stem not preserved.
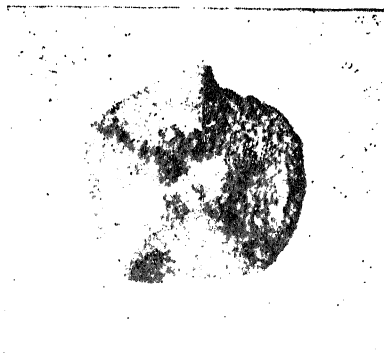
FIG. 1, *Agassizocrinus* sp., × 2

The present form closely resembles *Agassizocrinus conicus* Owen and Shumard[1] from the Chester formations of Illinois of America, No

definite specific identification however can be given at this stage, there being a single specimen only.

Department of Geology,
M. R. SAHNI.
Panjab University,
V. J. GUPTA.
Chandigarh, *November* 16, 1964.

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A *GRIFFITHIDES* FROM THE FENESTELLA SERIES OF KASHMIR

THIS note records the occurrence of *Griffithides* from the Fenestella Series of Kashmir. Only one specimen of a well-preserved glabella (along with eyes) was collected from the Black Shales exposed near Yanzar Fishing Rest House (33° 55′ : 75° 17′). The specimen closely resembles *Griffithides longiceps*, Portlock described from the Mississippian of Ireland.[1,2]

The glabella is pyriform and expanded anteriorly ; basal lobes distinct from glabella ; eye small and lunate ; the dimensions are : length 10·00 mm, ; width (at the anterior end) 7·50 mm. and (at the posterior end) 5·50 mm.

Fragments of trilobites comprising almost exclusively of pygidia are common in the Fenestella beds exposed near Yanzar, and are not in a satisfactory state of preservation for specific identification. No remains of Cephalothorax had been known till October 1964 when one of us (V. J. G.) found a well-preserved glabella from these rocks.

The known pygidia[3,4] have been identified as species of *Phillipsia* by various workers. But the associated glabella (Fig. 1) differs from that of *Phillipsia* by the absence of lateral glabellar furrows, nor obviously can we be absolutely certain that the pygidia and the (only) associated glabella belong to the same species.

The present form closely resembles *Griffithides longiceps,* Portlock from the Mississippian of Ireland. The characters of the glabella differentiate it from *Griffithides breviceps,* Gheyselinck and *Griffithides globiceps*. But no definite specific identification of the glabella can be given at this stage, there being a single specimen, not in organic union with the pygidium.

Dept. of Geology,
M. R. SAHNI.
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NITROGEN CONTENT OF THE LAMELLIBRANCH *DONAX CUNEATUS* LINNAEUS

THE chemical composition of several bivalves has been studied (Vinogradov).[1] The sand dwelling lamellibranch *Donax cuneatus,* however, has not been studied so far, and the present note reports the nitrogen content of this species occurring along the sandy shores of Tondi.

The total nitrogen and non-protein nitrogen were determined using the method described by Stayermark.[2] The protein values were calculated from the values obtained for protein nitrogen. Animals with meat weight ranging from 213 to 633 mg. were used in the present study.

TABLE I

Total nitrogen and protein and non-protein nitrogen of Donax cuneatus. *Each is a mean of 10 estimations*

No.	Wet weight mg.	Total nitrogen %	Non-protein nitrogen %	Protein nitrogen %	Protein %
1	258·06	2·84	1·04	1·80	11·25
2	358·14	2·70	0·99	1·71	10·69
3	466·20	2·42	0·70	1·72	10·75
4	633·00	2·38	0·87	1·51	9·44

The total nitrogen values vary from 2·38 to 2·84% of the body weight (wet weight), and

FIG. 1, *Griffithides* sp., × 2½.

there is a decrease in nitrogen content with increase in body weight. These values compare favourably with the values reported in other lamellibranchs like *Ostrea edulis, Mya arenaria, Pecten irradiatus,* and *Venus mercenaria* which were found to have a nitrogen value of 2·11%, 2·18%, 2·36% and 2·67% respectively (Payen[3]; Atwater[4]). Similarly, Balland[5] found 1·8% of nitrogen in the living matter of *Mytilus edulis* and Atwater (1892) found 1·56% in *Crassostrea virginica*. Srinivasan[6] has reported a nitrogen value of 2·56% in *Martesia fragilis* and 3·19% in *Martesia striata*. In *Donax* the non-protein nitrogen is much less, ranging from 0·7 to 1·04%. The mean values for non-protein nitrogen and total nitrogen are 0·90% and 2·59% respectively, the ratio of the two being 1 : 2·88.

From this, the calculated value for protein nitrogen is 1·69%. The total protein content calculated from this value is 10·53%, similar to the protein values in other bivalves. In *Ostrea edulis* the protein content ranges from 8·6 to 12·6%, in *Mytilus edulis* 8·9 to 11·7%, *Mytilus munahuensis* 11·3 to 19·4%, *Enoplochiton niger* 24·7%, *Pecten maximus* 17·5% and in *Cardium edule* it is 13·2% (Reviewed by Borgstrom,[7] 1962). In *Martesia fragilis* the protein content varied from 3·5 to 11·5% (Srinivasan, 1961). The protein content of *Donax cuneatus* which ranges from 9·44 to 11·25% is thus found to be comparable with the values obtained for other lamellibranchs.

Donax occurs in large numbers in our sandy shores. It is also used as a source of food by the poorer section of the people. Even though the protein content is generally less in bivalves than in fishes (8·8–23·8%) or Crustaceans (9·4–15·3%) they form a supplemental item in the food. Since *Donax* occurs in very dense populations they may perhaps be exploited to a greater extent than now.

I thank Prof. S. Krishnaswamy for his helpful suggestions.

Department of Zoology,   A. ABDUL RAHAMAN.
University of Madras,
Madurai Centre,
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DIURNAL VARIATION IN CHLOROPHYLL CONTENT OF LEAVES OF GROUNDNUT PLANTS (*ARACHIS HYPOGEA*)

THE controversy relating to continuous changes in chlorophyll content throughout the life of the leaf due to destruction of chlorophyll molecules in darkness and their regeneration in light was revived recently by Godnev *et al.*[1] Earlier, Wendel[2] observed large diurnal fluctuations in chlorophyll content and suggested the existence of diurnal rhythm for the same. Seybold[3] contradicted Wendel's views and doubted the correctness of his data. Virgin[4] noted that in young leaves protochlorophyll, precursor to chlorophyll *a* (a major component of total chlorophyll), is formed throughout the 24 hours but during daytime it cannot be isolated as it is immediately converted to chlorophyll *a*. Recently Wickliff and Aronoff[5] carried out a detailed study of the problem with an elaborate statistical lay-out and concluded on the basis of statistical analysis of their data that the mature leaves of soybean plants showed, if at all, a negligible variation of 1% in the chlorophyll content during a period of 24 hours thus proving the lack of diurnal variation. They however pointed out the possibility of its existence in young leaves which would need verification by measurements which eliminate the influence of biological variations. Keeping in view this precaution, the present investigation was carried out on relatively young leaves (second open leaves from the shoot-tips) of groundnut (TMV-2) plants.

Beginning at 7·00 a.m. on a clear day, samples (by punch method) were taken at random in triplicate at 3-hour intervals till next morning from the central portion of the proximal leaflets of the second leaf on the main shoot of 45 days old uniform plants, raised in pots kept in the open. Throughout the experiment one plant was sampled only once. Each of the three samples for each time of observation was immediately analysed for the total chlorophyll content according to Arnon's method,[6] using Bausch and Lomb 'Spectronic 20' colorimeter. The data are represented in the graph and also examined

statistically by the method of Analysis of Variance.

FIG. 1

The chlorophyll content increased rapidly in the morning, reached a maximum value of $36 \cdot 2 \mu g$. per unit leaf area (1 sq. cm.) and went down gradually to a minimum of $24 \cdot 5 \mu g$. at 1-00 a.m. It is thus in close agreement with the conclusion of Virgin[4] that young leaves show a maximum accumulation of protochlorophyll at about midnight which is rapidly converted to chlorophyll after sunrise.

Analysis of variance

Source of Variation	D.F.	Sum of Squares	Mean Sum of Squares
Time	.. 8	$310 \cdot 12$	$38 \cdot 76$
Linear regression	.. 1	$120 \cdot 10$	$120 \cdot 10$
Deviation from Linear	.. 7	$190 \cdot 02$	$27 \cdot 15$
Residual error	.. 18	$32 \cdot 51$	$1 \cdot 81$

The 'analysis of variance' shows high significance $(P < 0 \cdot 01)$ for differences among the mean values for the 'times of observation'. With the 'critical difference' of $3 \cdot 2 \mu g$. for $P < 0 \cdot 01$, it is seen that the 'day' values are significantly higher than the 'night' values, except for the intermediate value at 7-00 p.m. The statistical significance of the linear regression may also indicate the linear fall in the chlorophyll content from morning to midnight. The large and significant deviation from linear regression, which could not be reduced to even 50% by removing the polynomial contribution up to 4th degree, is perhaps due to asymmetrical wave nature of the curve. It requires confirmation by carrying out the study over a few days continuously at shorter time intervals and with more replications. Wickliff and Aronoff[5] apparently expected no change in the chlorophyll content throughout the 24 hours of their experimental period and so they considered the 1% variation, although statistically significant,

to be of no consequence; the linear regression was significant; but the deviation was very low and so they concluded the absence of diurnal variation in chlorophyll content in the mature leaves of soybean. In the present experiment, the leaves sampled were relatively young and apparently showed diurnal variation.

The authors wish to express their appreciation to Sri. V. Lakshminarasimham, Department of Statistics, concerning the statistical interpretation. This investigation was carried out incidentally in the project on 'Drought resistance in crop plants' financed by the Indian Council of Agricultural Research.

Department of Botany,   A. JAYARAMIREDDY.
S.V. University College,   I. M. RAO.
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* Original not seen.

MONOCHAETIA TURGIDA (ATK.) SACC. ON ROSA SP.—A NEW RECORD FOR INDIA

DURING the mycological survey in the month of January, 1964, some dead twigs of cultivated rose (*Rosa* sp.) were found to be infected with a *Monochœtia* sp. at the Government Horticultural Garden, Kanpur. A search of literature revealed no species of *Monochœtia* on this host from India, hence further studies were taken up to establish the identity of the fungus.

Morphology of the fungus.—Acervuli dark, scattered or gregarious, discoid, circular, triangular or oblong, bursting out through the epidermis, broken epidermis recurved back and giving star-like appearance, measuring $236 \cdot 7 - 2000 \times 66 \cdot 27 - 236 \cdot 7 \mu$; paraphyses numerous, slender and hyaline; conidia fusoid, broadly ellipsoid, unequal-sided or curved, 5-septate, with hyaline or slightly sooty and nearly cone-shaped end cells and hay's brown to light seal brown middle cells, apical hyaline cell of each conidium provided with a hyaline seta, conidia measure $20 \cdot 43 - 26 \cdot 9 \times 7 \cdot 47 - 10 \cdot 71 \mu$.

The diagnostic features of this fungus resemble *Monochœtia turgida* (Atk.) Sacc. described by Saccardo[2] and Guba[1] and is identified as such. This fungus is recorded only from America on dead leaves of *Cratœgus* sp. Hence it is the

first record of *Monochœtia turgida* (Fig. 1, *a* and *b*) on *Rosa* sp. from India.
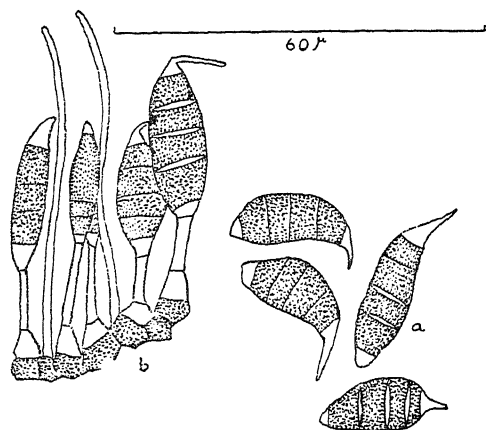
FIG. 1. Showing conidia, conidiophores and paraphyses of *Monochœtia turgida* (Atk.) Sacc. (*a*) Mature conidia. (*b*) A part of acervulus showing paraphyses and conidia in various stages of development, attached to conidiophores.

Thanks are due to Dr. J. C. F. Hopkins, Director, Commonwealth Mycological Institute, Kew, Surrey, England, and Mr. Sutton of C.M.I. for confirming the identification (I.M.I. accession No. 108636).

Laboratory of the Central   D. V. SINGH.*
   Potato Research Institute,   M. L. TRIVEDI.
Simla, *October* 13, 1964.

* Now Field Officer, Pests and Diseases, I.A.D.P., Ramgha Road, Aligarh.

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THE GENUS *ATHALAMIA* FALC. IN SOUTH INDIA

UP TO DATE there is no record of the genus *Athalamia* from South India. The family Sauteriaceæ, with its genera *Peltolepis*, *Sauteria* and *Athalamia*, has been known to be represented in Indian flora by the latter two genera chiefly in the Himalayas (Udar, 1958, 1960).

In a plant collection trip to several localities in South India during October 1961, one of us (Udar) collected a large number of specimens of *Athalamia* answering to *A. pusilla* (St.) Kashyap but showing some features of variation from it. The plants are particularly abundant on exposed moist rocks along the railway track from Mettupalayam to Ootacamund. They grow in dense, overlapping, light green patches in almost pure growth formations. The discovery of this plant is not only a significant addition to South Inlian flora but also provides an interesting representative of the Sauteriaceæ for study by students at local Universities and Colleges. The salient features of the South Indian plants are given below :

The plants are monœcious and protandrous. Quite often isolated plants show antheridia only and are suggestive of apparent diœcism but comparative female plants are never met with. Plants bearing sporophytes always show the presence of antheridia (Fig. 1). A similar condition has also been noted in the other Indian species, *A. pinguis* Falc. (Udar, 1960).

The thalli are delicate, usually light green and concolorous below. Younger thalli appear to innovate from tips of older thalli. The latter have their margins distinctly purplish, with purple coloration often extending to entire ventral surface. The presence of small ventral shoots are often noted but these are usually sterile. The plants are 3-10 mm. long and 1-4·5 mm. broad with a distinct mid-dorsal groove and the wings somewhat elevated. They branch dichotomously once or twice with the ultimate lobes linear to obovate and prominently notched at apex. The thallus surface shows conspicuous radiating lamellæ (Fig. 1) as described by Mehra (1957) forming indentations at the margins. The midrib is conspicuous but considerably compressed. The air chambers are empty, in 2-3 rows above the midrib (Fig. 7) and finally getting 1-layered at the margins. The cells surrounding the air chambers show chloroplasts.

The air chambers open externally by simple pores (Figs. 6, 7) which are somewhat elevated and surrounded by a ring of 5-6 cells. The radial walls of these cells are never thickened as is usual in *A. pinguis* (Udar, 1960).

The ventral scales are scattered in several irregular rows and are delicate and hyaline. In the basal part of the thallus they are occasionally tinged purple while in the old thalli they may be distinctly reddish-violet. They are lanceolate or acuminate with numerous cells projecting at their margins (Figs. 8, 9).

The rhizoids are both simple and tuberculate (Figs. 2-5). Colonies of blue-green algæ are very commonly noted in them but whether this association results in any benefit to the liverwort could not be ascertained. Majority of rhizoids modify at their tips forming basal attachment (Figs. 3, 5).
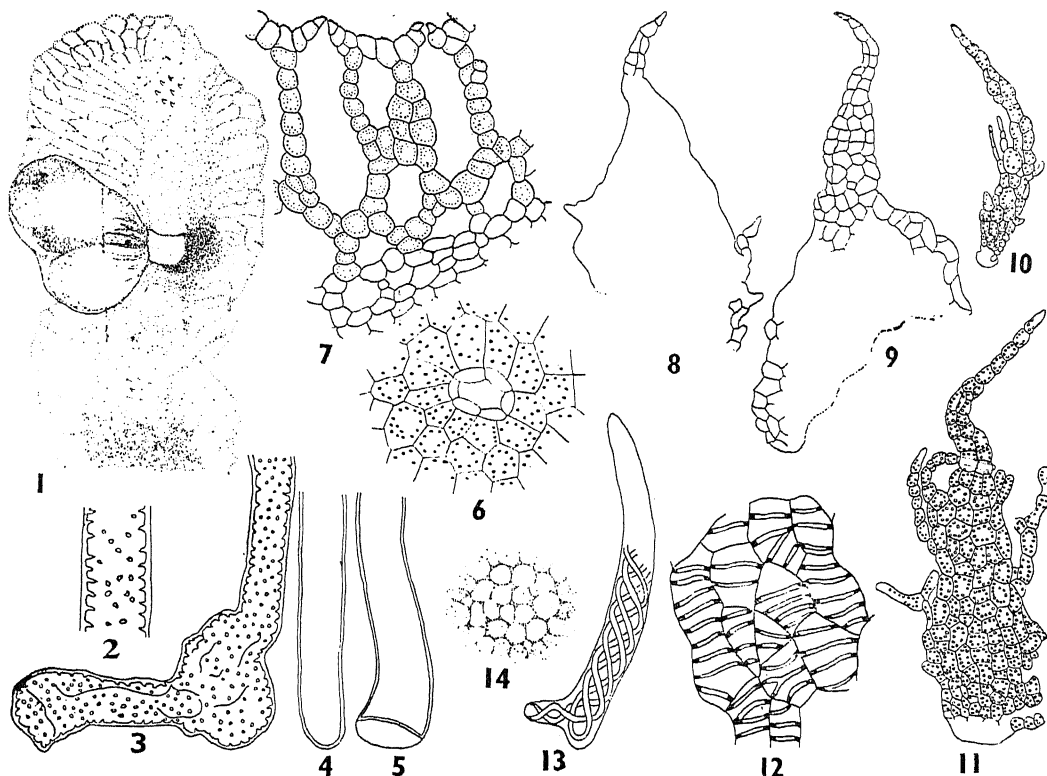
FIGS. 1-14. Fig. 1. A thallus showing two antheridial groups and a dorsal female receptacle, × 9. Fig. 2. A portion of tuberculate rhizoid, × 217·5. Fig. 3. A tuberculate rhizoid with attachment disc., × 145. Figs. 4-5. Simple rhizoids, × 145. Fig. 6. A pore from dorsal surface of thallus, × 200. Fig. 7. T.s. thallus across midrib, × 105. Figs. 8-9. Ventral scales. × 50. Figs. 10-11. Scales subtending the female receptacle, × 50. Fig. 12. Capsule wall in surface view, × 200. Fig. 13. A trispiral branched elater, × 217·5. Fig. 14. Spore, × 145.

The antheridia lie embedded in the thallus and scattered in groups behind the female receptacle (Fig. 1). There may be up to four antheridial groups on a thallus alternating with the female receptacles.

The female receptacle is stalked and dorsal in position (Fig. 1). Normally there are two more or less upwardly directed involucres in a receptacle each with a single archegonium. The base of the receptacle is surrounded by numerous hyaline and linear scales (Fig. 1) with marginal filamentous outgrowths and with cells having a number of chloroplasts (Figs. 10, 11). These scales remain attached below the disc when the stalk elongates. The latter shows no scales over its surface and is devoid of a rhizoidal furrow.

The capsule wall is one cell layer thick with conspicuous annular thickening bands (Fig. 12). The mature capsule dehisces by irregular valves which get reflexed. The mature spores (Fig. 14) are light brown, papillate, 52·8–67·2 μ in diameter (including the papillæ). Kashyap (1929) observed the spore size to be 45–50 μ, in the West Himalayan plant while Hattori and Shimizu (1955) found 45-52 (–60) μ in the type specimens of *A. pusilla* from the same area. It appears that the plants in the Western Himalayas have comparatively smaller spores than in the South Indian plants. The elaters are also extremely variable in size. They are brown and may be bispiral-trispiral (Fig. 13), 115·2–230 μ long and 9·6–14·4 μ thick. Kashyap (1929) gives 140–180 μ as their size and Hattori and Shimizu (1955) found it to be 140–160–200–240 μ. Evidently the South Indian plants show a somewhat longer size range and a greater degree of variability. They are comparatively wider also (*cf.* Hattori and Shimizu, 1955 who give the width as *ca.* 8 μ).

to one of us (Udar) under which the present work was completed.

Department of Botany,   RAM UDAR.
Lucknow University,   S. C. SRIVASTAVA.
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December 29, 1964.

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A NEW SPECIES OF *SCOPULARIOPSIS*

WHILE attempting to isolate *Helminthosporium* sp. from wheat leaf, light black leaf-spots were observed, and on plating constantly gave rise to a fungus, *Scopulariopsis*.

It has been found from the literature that only one species has been reported and that too from soil in India.[1] As parasitic species is not yet recorded from anywhere, this species was studied in detail from morphological and cultural points of view. All the characters were compared with those of species from soil and were found to be quite different and hence this has been reported here as a new species.
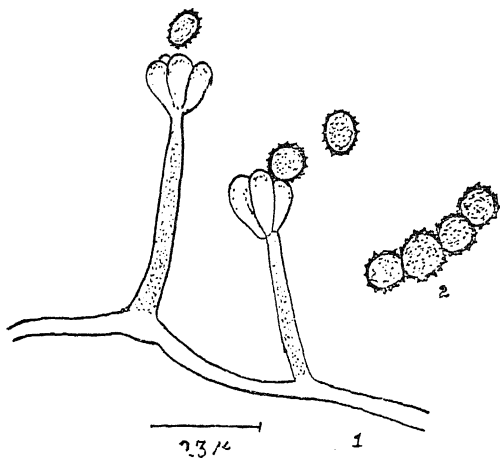
FIGS. 1-2. Fig. 1. A conidiophore bearing phialides and conidia. Fig. 2. Chain of conidia.

Scopulariopsis tritici SP. NOV.

Mycelial colony on PDA light-coloured, hyphæ 5-6 μ hyaline; conidiophores septate, 50-55 μ usually simple with a cluster of 3-4 phialides, 13-15 μ long, light brown; conidia 11·5 × 9·5 μ, globose, dark brown, echinulate, one-celled catenulate.

Scopulariopsis tritici SP. NOV.

Mycelium in PDA pallidium; hyphæ 5-6 hyalinæ; conidiophora septata, 50-55 μ vulgo simplicia, 3-4 phialidibus præsentibus 13-15 μ, pallide brunnea; conidia 11·3 × 9·5 μ, globosa, fusce brunnea, echinulata, unicellularia catenulata.

The type specimen and cultures have been deposited in Herbarium Cryptogamæ Indiæ Orientalia, New Delhi and Herbarium of Botany Department, Marathwada University, Aurangabad, India.

We are grateful to Rev. Fr. Dr. H. Santapau Director, Botanical Survey of India, Calcutta-13, for kindly rendering the Latin diagnosis of the new species.

Botany Department,   K. B. DESHPANDE.
Marathwada University,   K. S. DESHPANDE.
Aurangabad (India),
October 12, 1964.

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A FREAK DWARF MUTANT INDUCED BY FAST NEUTRON IN RICE

THE dry seeds of rice variety As. 35 were irradiated with fast neutron as well as with thermal neutron at National Brookhaven Laboratory, U.S.A., through the courtesy of Atomic Energy Establishment, Trombay, Bombay. Two treatments were given, namely, (i) fast neutron for 2 hours 16 minutes and (ii) thermal neutron for 16 hours.

The irradiated material under both the treatments were grown in the main season as well as in the second crop season. N_2-generation was studied in the second crop season (December 1958 to April 1959). In N_2-generation a *freak dwarf mutant* was observed under fast neutron treatment. Artificial induction by ionising radiations effecting various plant parts in rice are known.[1,4,6] The object of this letter is to record some interesting features of this newly induced mutation.

The *freak dwarf* mutant induced by fast neutron resembled Akemine's dwarf[5] in plant

height, and varied from 18 cm. to 28 cm. in stature. All the plants were uniform in appearance and produced very short broad spikelet, having empty pollen grains. The leaves were short, broad, and slightly hairy; and the plant was late in flowering duration. Ligule also showed malformations. Out of 26 plants, three plants developed lutescent[7] type of chlorophyll deficiency in N_2-generation and ultimately died. The plants produced abnormal panicles, were completely sterile and very abnormal in morphological characters. All the organs of the plant were highly condensed in vegetative growth as shown in Fig. 1.

FIG. 1. Photograph showing comparison between the freak dwarf mutant (right) and a normal plant of variety As. 35 (left).

An N_3-generation of line No. 15, from which the freak dwarf mutant was secured, was grown. The population segregated for tall and dwarf in 3 : 1 ratio (Table I). Mitotic studies revealed that the somatic chromosome number was 24. One chromosome in the somatic complement was found to be abnormally long and another was observed to be abnormally short. It is presumed that this situation was brought about by segmental translocation.

TABLE I

Showing segregation for the normal tall and the freak dwarf mutant in neutron-irradiated As. 35 in N_3-generation

Family	Normal tall	Freak dwarf
16–13	252	66
15–17	230	89
15–37	206	53
Observed Total ..	688	208
Expected on 3 : 1 ratio ..	672	224

N_2-generation segregated for high and low spikelet sterility and the former group might consist of plants heterozygous and homozygous for translocation while the low spikelet sterility group of normal plants.[2,3,5,8] The above data show that the freak dwarf mutant is caused by segmental translocation brought about by the fast neutron treatment.

Grateful thanks are due to Shri S. Sampath, Cytogeneticist, under whose guidance this work was done at Central Rice Research Institute, Cuttack.

Sugarcane Research Institute,   B. N. SAHAY.
Pusa (Bihar), *October* 25, 1964.

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PRODUCTION OF CELLULOLYTIC (Cx) ENZYME BY *ALTERNARIA TENUIS*

Alternaria tenuis, a leaf-spot pathogen, was reported in an earlier communication to secrete protopectinase (PP), polygalacturonase (PG) and pectin-methyl-esterase (PE) enzymes in synthetic medium. After studying various cultural factors, a culture medium M was evolved for the production of active pectic enzymes.[1] The present note presents the investigations on the production of cellulolytic enzyme (Cx) by the same fungus on the medium M and its various modifications.

M = 1·0% pectin, 0·2% asparagine, 0·3% KH_2PO_4 and 0·05% $MgPO_4$ $7H_2O$.

M_1 = 0·2% asparagine, 0·3% KH_2PO_4 and 0·05% Mg PO_4 $7H_2O$.

A = M_1 + 1·0% cellulose powder.

B = M_1 + 1·0% carboxyl methyl cellulose.

C = M_1 + 1·0% filter-paper.

D = M_1 + 1·0% glucose.

E = M_1 + 0·5% pectin + 0·5% cellulose powder.

F = M_1 + 0·5% pectin + 0·5% carboxyl methyl cellulose.

The cultures were incubated for five days at 25° C. and the Cx activity was determined by following the loss in the viscosity of 1·0% carboxyl methyl cellulose solution over a period of 30 minutes. The results are shown in Fig. 1.
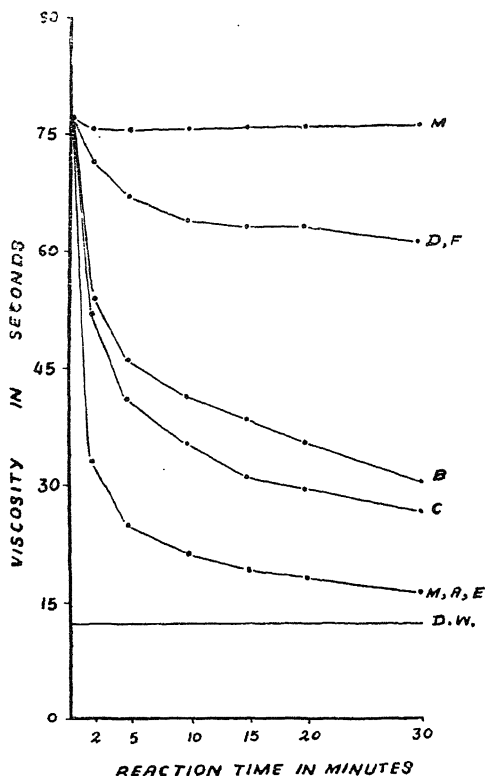
It was concluded from the results that the fungus secretes active cellulolytic enzyme (Cx) extra cellularly on synthetic medium. The production of the enzyme was, however, better in presence of pectin and cellulose powder than in the presence of carboxyl methyl cellulose, filter-paper or glucose alone.

The author is grateful to Dr. S. C. Gupta for his guidance.

Department of Botany,   D. K. PANDEY.
K.N. Government College,
Gyanpur (Varanasi),
October 30, 1964.

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A NEW BACTERIAL LEAF-SPOT DISEASE OF *BAUHINIA RACEMOSA* LAMK.

Bauhinia racemosa, a small, crooked tree, (venerated by the Hindus on the Dassera day) is widely distributed throughout India, China, Ceylon and Timor. Its leaves commonly known as *Apta* or *Ahitra* are used in making indigenous cigarettes called Bidis. A severe bacterial leaf-spot, causing considerable reduction in the market value due to rotting of leaves, is widespread in South Gujarat.

Early symptoms of infection are evident in the form of very minute, pale brown spots surrounded by water-soaked area. In the advanced stage of infection, spots appear dark with brown centres, round to irregular in shape and measure up to 1·5 mm. Encrustation probably due to drying of the exudate is generally evident. Veins seem to be more susceptible than petioles. Younger leaves are more susceptible than the older ones.

Young lesions when examined under the microscope show powerful bacterial ooze from the cut ends of the lesion. The causal organism was isolated by the usual dilution poured plate technique using potato dextrose agar. Isolations from these lesions yielded a pure culture of bacterium which on agar slant gave smooth, copious, butyrous, entire, circular, glistening, lemon yellow growth, characteristics of *Xanthomonas*.

After establishing the pathogenicity of the organism on *B. racemosa*, further experiments were undertaken to ascertain its host range. The results showed that it neither infected the other two spp. of *Bauhinia*, nor *Cassia tora* L., *Tamarindus indica* L., *Pisum sativum* L., *Dolichos lablab* L. and *Vigna sinensis*.

CULTURAL AND PHYSIOLOGICAL CHARACTERS

The bacterium is a short rod with rounded ends, occurring singly, measuring $1·6 \times 0·54 \mu$, gram negative, capsulated, non-spore forming, non-acid fast and motile with a polar flagellum. It grows profusely on potato dextrose agar, M_2 medium and Czapek's agar, but moderately on nutrient agar and in nutrient broth after 48 hours. It hydrolyses starch, digests casein moderately, liquefies gelatin, peptonises milk, reduces litmus with colour changes from lavender through pink to colourless, does not produce H_2S and NH_3 from peptone. V.P. and M.R. tests negative, citrate utilised but not uric acid, acid without gas in glucose, sucrose and maltose; salicin not utilised. Strictly aerobic; optimum temperature for growth 27–31° C.; thermal death-point 52° C,

The bacterium is presented as a new species under the name of *Xanthomonas bauhiniæ* sp. nov.

Pathogenic on leaves of *Bauhinia recemosa* Lamk. only. The disease is found at several places in Gujarat State.

Garda College and Baria
  Science Inst., Navsari,
Gujarat State,
December 5, 1964.

A. C. PADHYA.
M. K. PATEL.
W. V. KOTASTHANE.

RECORD OF LUCERNE SEED INFESTING CHALCIDOIDS FROM INDIA

THE seed-infesting chalcidoids besides affecting the germinability or the commercial value of the seeds are also important from quarantine point of view since the infested seeds do not bear any external evidence of their presence within. This group of insects often causes very serious damage; as many as 40% mericarps of fennel seeds (*Fœniculum vulgare*) have been reported to be damaged by the eurytomid, *Systole albipennis* Wlk. (Gupta, 1962). This species has recently been recorded for the first time from India infesting fennel seeds (Batra *et al.*, 1959).

While examining a sample of lucerne seeds (*Medicago sativa,* N.O. Leguminosæ), some seeds were noticed to bear small circular holes very much like those made by the seed-infesting chalcidoids. Therefore samples of unripe lucerne seeds were collected from the Indian Agricultural Research Institute Farm, from Pahasu fields near Khurja, Uttar Pradesh and from the Remount Depot Farm, Babugarh, near Hapur, Uttar Pradesh, and kept under observation. In a few days large number of insects emerged in all the samples which were identified as *Bruchophagus gibbus* Howard and *B. roddi* Guss. (Eurytomidæ) along with their parasite, *Habrocytus* sp. (Pteromalidæ). From I.A.R.I. sample, another parasite, *Eupelmus* sp. (Eupelmidæ), also emerged. The details of the emergence of the pests and the parasites are presented in Table I. This is the first record of these two species of *Bruchophagus* from India. This genus, however, is already represented in India by *B. mellipes* Gahan, damaging *dhaincha* and red gram seeds (Mani, 1938).

B. roddi and *B. gibbus* are noted pests, the former infesting alfalfa and the latter red clover

TABLE I

Showing the percentage emergence of pests and parasites from lucerne seeds

Locality	No. of insects emerged per 100 seeds	No. of parasites per 100 insects	Incidence of pests per 100 insects (females)	
			B. gibbus	*B. roddi*
I A.R.I., New Delhi	12·02	22·02	43·17	16·49
Pahasu U.P.	5·41	25·00	58·95	4·62
Babugarh, U.P.	21·22	16·66	36·26	30·58

seeds. As many as 83% seeds of alfalfa seeds have been reported to be damaged by *B. roddi* in the western United States (Strong, 1962 b). Since this is the first record of the species, it appears necessary to ascertain the distribution and check further spread to newer fields through suitable domestic quarantines.

With a view to eliminate the confusion resulting from the indiscriminate use of the name *B. gibbus* for the eurytomid emerging from legumes, Strong (1962 b) concludes that both in North America and in the Palæarctic region, *B. roddi* will be used in reference to those eurytomids emerging from alfalfa and *B. gibbus* to those emerging from red clover (*Trifolium pratense*), but the record of both these species from alfalfa seeds from India does suggest a possibility of both the species infesting the same host.

Division of Entomology,
Indian Agricultural
  Research Institute,
New Delhi-12, *November 7, 1964.*

S. R. WADHI.

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REVIEWS AND NOTICES OF BOOKS

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The subject-matter of Volume 2 is dealt with in ten chapters as listed below: (1) Animal Photoperiodism, by Albert Wolfson; (2) Phototaxis in Micro-organisms, by Roderick K. Clayton; (3) The Photoreceptor Process in Lower Animals, by Donald Kennedy; (4) Vision as a Photic Process, by W. A. H. Rushton; (5) The Physical Limits of Visual Discrimination, by H. B. Barlow; (6) Studies on Ultraviolet Radiation Action Upon Animal Cells, by Arthur C. Giese; (7) Mutagenic Effects of Ultraviolet and Visible Light, by G. Zetterberg; (8) Photoreactivation of Ultraviolet Damage, by Claud S. Rupert; (9) Photochemistry of the Nucleic Acids, by Kendric C. Smith; and (10) Bioluminescence—Production of Light by Organisms, by Aurin M. Chase.   C. V. R.

Advances in Analytical Chemistry and Instrumentation (Vol. 3). Edited by C. H. Reilley. (John Wiley and Sons, Inc., 605, Third Avenue, New York, N.Y.), 1964. Pp. vii + 523. Price $15.00.

This series in the field of analytical chemistry is intended to present significant new ideas and techniques as well as the status of important, but more classical methods. The present volume contains the following articles: (i) Atomic Absorption Spectroscopy, by R. Lockyer; (ii) Photometric Titration, by A. L. Underwood; (iii) Analytical Applications of Enzyme-Catalyzed Reactions, by W. J. Blaedel and G. P. Hicks; (iv) Ion Sources and Detectors for the Mass Spectroscopic Study of Solids, by L. F. Herzog, D. J. Marshall, B. R. F. Kendall, and L. A. Cambey; (v) Galvanic Analysis, by P. Hersch; (vi) Linear Elution Adsorption Chromatography, by Lloyd R. Snyder; (vii) Concepts and Column Parameters in Gas Chromatography, by J. Calvin Giddings; and (viii) Thin-Layer Chromatography, by Rene Maier and Helmut K. Mangold.   C. V. R.

Advances in Organometallic Chemistry (Vol. 1). By F. G. A. Stone and R. West. (Academic Press, Inc., 111, Fifth Avenue, New York-3, New York), 1964. Pp. 334. Price $11.00.

Of recent years the study of organometallic chemistry has grown rapidly. In particular, the subject has advanced by reason of the discovery of several classes of compounds possessing remarkable structures, by the development of valence theory which accounts for the existence of such compounds and for the nature

of carbon-metal bonds, as also by the growing use of organometallics in industrial processes. The serial publication is intended to publish authoritative reviews on recent developments in all aspects of the subject.

The present volume contains the following chapters: (i) Diene-Iron Carbonyl Complexes and Related Species, by R. Pettit and G. F. Emerson; (ii) Reactions of Organotin Hydrides with Organic Compounds, by Henry G. Kuivila; (iii) Organic Substituted Cyclosilanes, by Henry Gilman and Gerald L. Schwebke; (iv) Fluorocarbon Derivatives of Metals, by P. M. Treichel and F. G. A. Stone; (v) Conjugate Addition of Grignard Reagents to Aromatic Systems, by Reynold C. Fuson; and (vi) Infrared and Raman Spectral Studies of π Complexes Formed between Metals and C_nH_n Rings, by Heinz P. Fritz.   C. V. R.

Tacheometric Tables (Fourth Impression). By F. A. Redmond. (Asia Publishing House, Bombay-1), 1964. Pp. 256. Price Rs. 15·00.

Tacheometry is an advanced form of surveying, useful in many ways. If it is not as popular as it should be, it is because of the tedious labour associated with the process of reducing the readings. The present Tables, first published in 1951, were intended to remove this handicap and thus promote the practice of tacheometry by surveyors. The original compilation was the result of painstaking and devoted task extended over three years by the author.

That a fourth reprint of the Tables has been called for shows that tacheometric survey is gaining ground; it also vouchsafes for the accuracy of the data compiled here.

The Tables give the horizontal and vertical distances required by the surveyor from staff intercepts read into a Tacheometer. The angles range from 0° to 20° by 20' intervals and distances range from 50 to 850 ft. The ten-page introduction explains the fundamental formulæ involved and the use of the Tables.
                                                                              A. S. G.

Handbook of Manures and Fertilisers. (Indian Council of Agricultural Research, New Delhi), 1964. Pp. 333. Price Rs. 6·50.

The present need for concentrating all efforts at increasing agricultural production in the country cannot be over-emphasized. It is necessary in this context that scientific knowledge gained through research and experimentation should be brought home to the farmers and growers who are actually engaged

in the fields. The task is not an easy one as traditional methods of cultivation have generally a greater appeal and innovations are looked upon with doubt. In fertilizer practice, for example, it is important that organic manures and chemical fertilizers should be used more discriminately and less routinely. Excessive or indiscriminate or untimely use may not yield the expected results. The several agencies employed by the government for educating the farmers in the use of fertilizers by practical and convincing demonstrations have a responsible duty to perform. The compendium which is a co-operative work of experts has been prepared by the Indian Council of Agricultural Research, New Delhi, and deals in a precise manner with all aspects of manuring and use of fertilizers and nutrients applicable to different crops grown in India. The principles discussed and the presentation of the materials are such that the book is sure to have even a wider appeal.

A. S. G.

International Conference on Cosmic Rays—Proceedings.

Volume 1 : *Solar Particles and Sun-Earth Relations.* Pp. 265. Price Rs. 20·00.

Volume 2 : *Modulation.* Pp. 470. Price Rs. 30·00.

The Eighth International Conference on Cosmic Rays was held in Jaipur, India, from December 2-14, 1963. The Proceedings of the Conference are being published in six volumes. We had occasion to review the two volumes 4 and 5 that had come out earlier (*Curr. Sci.,* 1964, 33, 478 and 693). Volume 1 contains 23 papers contributed by 35 authors and Vol. 2, 59 papers contributed by more than 100 authors.

Copies can be had from the Organizing Committee, c/o. Tata Institute of Fundamental Research, Colaba, Bombay-5 (BR) (India).

Atoms, Molecules and Quanta (Vols. 1 and 2). By A. E. Ruark and H. C. Urey. (Dover Publications, 180, Varick Street, New York-14, N.Y.), Pp. xvi + 447. Price $ 2.50 ; Pp. 448-810. Price $ 2.50.

Ever since its first publication 35 years ago the book *Atoms, Molecules and Quanta* by A. E. Ruark and H. C. Urey, more familiarly known as only "Ruark and Urey", remained for over two decades as a favourite text-book with students and teachers of advanced physics. The book is concerned essentially with extra-nuclear properties of isolated atoms and molecules, and

their interaction with radiation and bombarding particles—mainly on a non-relativistic basis.

The book still remains as one of the best on the subject with its clear exposition of the vital theories and experiments connected with atomic and molecular physics.

Originally intended for post-graduate and research students, the contents of the book are mostly covered now in the first years of the graduate courses in physics. Hence there is a need for a low-priced edition and the Dover paperbacks meet this demand.

The Dover reprint which appears in two handy volumes has been emended by the authors and contains supplementary notes at the end which bring the references more up-to-date. A. S. G.

Books Received

Molecular Complexes in Organic Chemistry. By L. J. Andrews and R. M. Keefer. (Holden-Day, Inc., San Francisco), 1964. Pp. viii + 196. Price $ 8·75.

Absolute Stability of Regular Systems (Translated by E. Polak). By M. A. Aizerman and F. R. Gantmacher. (Holden-Day, Inc., San Francisco), 1964. Pp. 172. Price $ 8.95.

Dynamic Stability of Elastic Systems. By V. V. Bolotin. (Holden-Day, Inc., San Francisco), 1964. Pp. xii + 451. Price $ 12.95.

Advances in Ecological Research (Vol. 2). Edited by J. B. Cragg. (Academic Press, Inc., London Ltd., Berkeley Square House, London W. 1), 1964. Pp. xi + 264. Price 57 *sh.* 6 *d.*

The Natural History of Aggression—Institute of Biology Symposium No. 13. Edited by J. D. Carthy and F. J. Ebling. (Academic Press, Inc., London Ltd., London W. 1), 1964. Pp. vi + 159. Price 30 *sh.*

The Arlington Practical Botany (Book I)—*Plant Anatomy.* By Mary-Anne Burns. (Arlington Books, 15 Duke Street, London S.W. 1), 1965. Pp. 93. Price 15 *sh.*

Progress in Astronautics and Aeronautics (Vol. 14). Edited by Victor G. Szebehely (Academic Press, New York), 1964. Pp. xix + 744. Price $ 10.75.

The Red Blood Cell—A Comprehensive Treatise. Edited by C. Bishop and D. M. Surgenor (Academic Press, New York), 1964. Pp. xiv + 566. Price $ 17.00.

Evaluation of Drug Activities (Vols. I and II). By D. R. Laurence and A. L. Bacharach. (Academic Press, Inc., London Ltd., London W. 1), 1964. Vol. I : Pp. xvii + 456. Price 90 *sh.* ; Vol. II : Pp. vii + 457–900. Price 95 *sh.*

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Nuclear Physics to Shri K. M. M. S. Ayyangar for his thesis entitled "Studies on the Lifetimes of Excited States of Atomic Nuclei"; Ph.D. degree in Chemistry to Shri A. Prabhakara Rao for his thesis entitled "Studies on the Use of Papers and Columns Treated with Ion Exchangers for Analytical Separation"; Ph.D. degree in Zoology to Shri G. Chandrasekara Rao for his thesis entitled "Studies on Marine Interstitial Fauna Inhabiting the Sandy Beaches of Waltair Coast".

Sri Venkateswara University has awarded the Ph.D. degree in Chemistry to Shri D. Adinarayana Chetty for his thesis entitled "A Structural Study of the Chemical Components of a few Indian Plants"; Ph.D. degree in Botany to Messrs. M. Vittal Rao and P. Gopala Rao for their theses entitled "Studies on the Root-infecting fungi with Special Reference to Microbial Antagonisms" and "Physiological Studies on the Influence of NAA and MH on the Acid Metabolism and Related Phenomena in Groundnut Seeds during Germination and Seedling growth in Dark" respectively.

Orbitron Vacuum Pump

The orbitron is a device in which electrons are orbited in a cylindrically symmetric electrostatic field between an outer cylinder which may be grounded and an axial rod or wire which is held at a positive potential. The principle of the orbitron was discovered during attempts to develop an efficient ion gauge. Soon after the successful application of the orbitron as an ion gauge it was tried as a getter ion pump, where it was immediately successful. In these early pumps the orbitron device served only to ionize the gas, and evaporation or sublimation was obtained either from a primer type assembly or with direct bombardment of a titanium rod by electrons from an auxiliary filament.

Scientists of the University of Wisconsin report the construction of an orbitron vacuum pump in a casing 10 cm. in diam. in which electrons are orbited around a central anode consisting of a tungsten rod supporting a titanium cylinder. Electrons have mean free paths of several hundred cm., they ionise inert gas and they heat the titanium cylinder to give sublimation. The pump was found dependable and stable in operation, and in one test went up to a pressure of 7×10^{-10} Torr.—(*Rev. Sci. Insts.*, 1965, 36, 1.)

Angular Dependence of the Raman Scattering

The angular dependence of Raman scattering has never been successfully studied up to now due to the difficulty in obtaining well-collimated exciting beams maintaining both a well-defined frequency and a strong enough intensity. The discovery of the laser has provided the above requirements for a source, and accurate studies can now be undertaken on the angular dependence of Raman scattering. The importance of such studies lies in the fact that they would provide information for identification of point-group symmetries of molecular transitions.

In a communication to *Physical Review Letters* (January 4, 1965) Leite, Porto and Damen of the Bell Telephone Laboratories, New Jersey, report preliminary results on the angular dependence of some Raman emission lines from benzene, using the He-Ne gas laser, and photo-electrically recording the scattering.

The angular distribution intensity of the 992 cm.$^{-1}$ vibrational frequency of benzene which has Alg symmetry follows a $\cos^2\theta$ law as was theoretically predicted for isotropic Raman scattered radiation.

The angular dependence of the 1585-1606 cm.$^{-1}$ doublet, both e_{2g} symmetry, follows a quadrupole type of scattering and the angular intensity distribution is in good agreement with Placzec's theoretical expression $1 + (\cos^2\theta)/13$.

A more involved case is furnished by the 3049–62 cm.$^{-1}$ doublet whose frequencies have different vibrational symmetries (e_{2g} and a_{1g} respectively). This is a combination of a quadrupole with an isotropic type of scattering, and the observed angular intensity distribution is found to be consistent with the above description.—(*Physical Review Letters*, 1965, 14, 9.)

Boron Requirement of a Marine Diatom

Boron has been known to be an essential micronutrient for growths of higher plants and is now thought to play a role in the formation of the cell-wall. In this connection a study of the boron requirement of a marine diatom has special interest since the diatom cell-wall is chemically and structurally unique by reason

of the absence of cellulose and the presence of silica.

J. C. Lewin of the Scripps Institution of Oceanography, California, reports an experiment on the study of the boron requirement of *Cylindrotheca fusiformis,* a marine pennate diatom. Since sea-water already contains 4·5 mg./l. of boron, the experiment with the marine organism can be demonstrated only in an artificially constituted medium in which the boron concentration can be limited. A synthetic saline medium simulating in all essentials (except for boron) the sea-water, where diatoms grow, has been devised to test the growth of *C. fusiformis.* Boron was supplied as H_3BO_3 at 0·5 mg./l. All growth experiments were carried out in plastic bottles containing 50 ml. of culture medium. It was found that when boron was omitted from the nutrient medium *C. fusiformis* did not grow.—(*Naturwissenschaften,* 1965, 52, 70.)

The Raman Effect in Crystals

The latest issue (1964, 13, No. 52) of *Advances in Physics,* the Quarterly Supplement of the Philosophical Magazine, contains a review article by R. Loudon which gives the progress in the theoretical and experimental study of the Raman Effect in crystals during the past ten years. The article draws attention to the theory of those properties of long-wavelength lattice vibrations in both cubic and uniaxial crystals which can be studied by Raman scattering. In particular the phenomena observed in the Raman scattering from crystals which lack a centre of inversion are related to the theory. The article also discusses how the angular variations of the scattering by any type of lattice vibration in a crystal having any symmetry can be easily calculated by using a complete tabulation of the Raman tensor. Recent measurements of first-order lattice vibration spectra are listed. There is also a discussion of Brillouin scattering.

The relation of second-order Raman spectra to critical points in the lattice vibration density of states is discussed, and measurements of the second-order spectra of diamond and alkali halides are reviewed.

The theory and experimental results for Raman scattering by electronic levels of ions in crystals are examined, and proposals for Raman scattering by spin waves, electronic excitations across the superconductive gap and by plasmons are collected together.

Finally, the prospects for applying lasers as sources for Raman spectroscopy are discussed, and progress in the new technique of stimulated Raman scattering is reviewed.

Aggregation of Ice Crystals in Strong Electric Fields

Experiments have demonstrated that the adhesion of ice crystals on collision is a sensitive function of temperature, humidity and crystal type. However, the effect of electric fields on the adhesion of ice crystals has not been so far examined. It appears possible that the attractive forces between ice cystals, produced by polarization charging within the field and accentuated because of the small radius of curvature of the crystal edges, may produce increased aggregation.

J. Latham and C. P. R. Saunders describe experiments to test this hypothesis. Ice crystals were formed at a predetermined temperature inside a cold chamber by producing a water cloud and seeding it with pellets of solid carbon-dioxide. While the crystals were growing inside the chamber, two small water drops of known identical diameter were suspended from tips of fine glass fibres located centrally within two identical ebonite tubes, and were then frozen. Windows in the walls of the ebonite tubes permitted visual observations or photography of the spheres. Arrangements were also made to expose one of the ice spheres to an electric field up to about 4000 V/cm.

Results showed that for field strengths below about 800 V/cm. there was no detectable difference between the masses collected by the two spheres, but for higher fields the mass collected by the sphere exposed to the electric field was considerably greater than that collected by the sphere in the field-free tube.

These experiments demonstrate that ice crystal aggregation is appreciably influenced by the presence of strong electric fields. The results are of meteorological importance on the formation of snow flakes inside thunderclouds where the crystal concentrations are high and fields of several thousand V/cm. have been measured. —(*Nature,* 1964, 204, 1293.)

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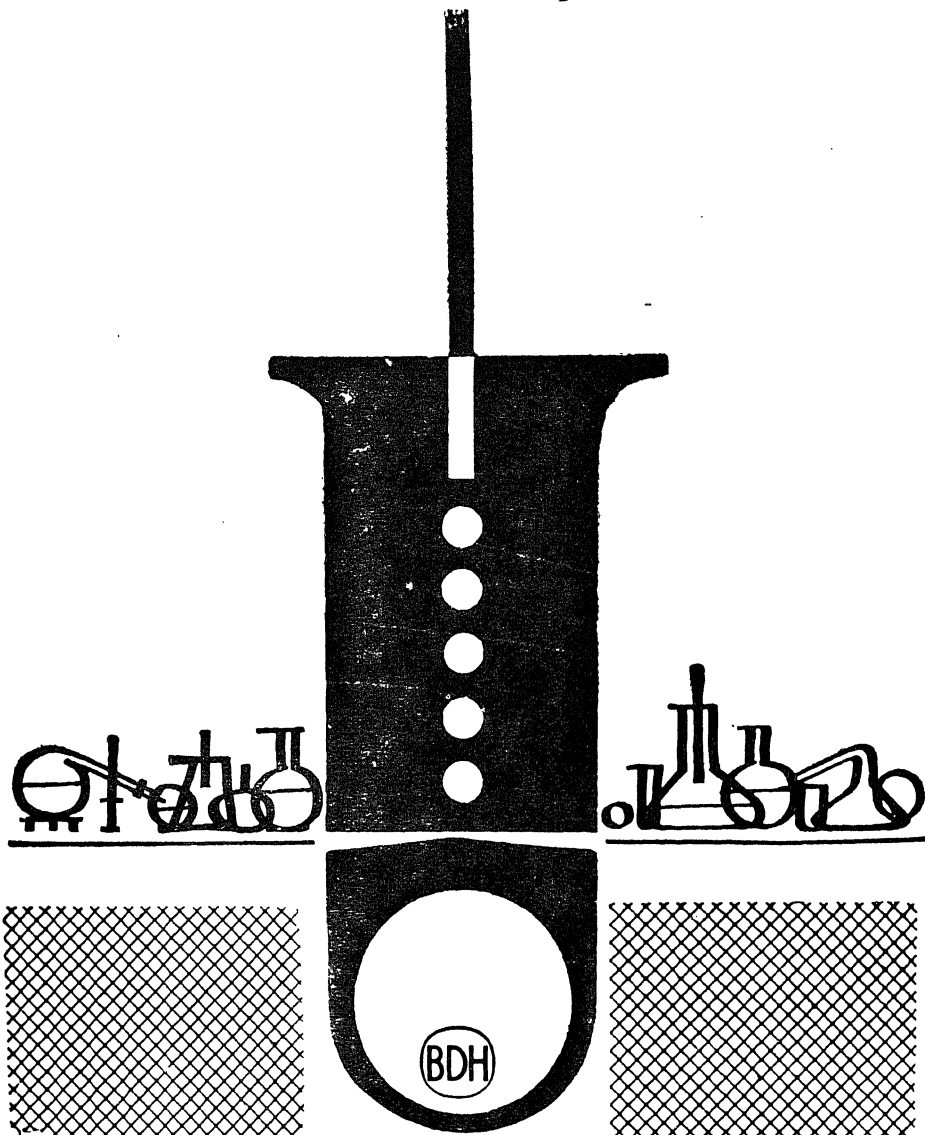
THE NEW PHYSIOLOGY OF VISION
Chapter XV. The Chromatic Responses of the Retina

Sir C. V. RAMAN

IT is of fundamental importance for an understanding of the nature of vision to know how the retina in the living state reacts when light is incident on it. Neither anatomy nor biochemistry can possibly furnish us with that knowledge. We may here recall how immensely useful the ophthalmoscope is by its enabling us directly to view the living retina and observe its state or condition. Likewise, it is evident that any technique by which the process of the excitation of the retina by light is brought within the scope of direct observation would be of the highest importance for our understanding of the visual processes. Soon after the author commenced the investigations of which the results are described in the present treatise, a technique was developed by him which had evidently great possibilities of becoming just such a tool of research as that envisaged above. Since then the technique has been improved to such an extent as to make it a precise and reliable method for the study and analysis of our visual sensations. We shall proceed to describe and explain the technique and to indicate in general terms the nature of the results which emerge.

The Principle of the Method.—The essence of the method of observation is the use of a colour filter which freely transmits light over the entire range of the visible spectrum except over a limited and well-defined region which it completely absorbs. It is possible by the use of suitable dye-stuffs in appropriate concentrations to prepare colour filters of gelatine films on glass exhibiting the spectroscopic behaviour described. Holding such a colour filter before his eye, the observer views a brilliantly illuminated screen for a brief interval of time and then suddenly removes the filter while continuing to view the screen with his attention fixed at a particular point on it. He then observes on the screen a picture in colours which is the chromatic response of the retina to the light of the colour previously absorbed by the filter and which impinges on it when the filter is removed. Actually, as will become clearer presently, what the observer sees is a highly enlarged view of his own retina projected on the screen and displaying the response of the retina in its different areas produced by the incidence of the light of the selected wavelengths. By using a whole series of colour filters whose characteristic absorptions range from one end of the visible spectrum to the other, we are enabled to explore the behaviour of the retina over an extensive region (including especially the foveal area) under excitation by light of different wavelengths which in the aggregate cover the entire visible spectrum.

Why the phenomenon described above manifests itself is not difficult to understand. A colour filter completely absorbing a selected part of the spectrum when placed before the eye of the observer protects the retina from the incidence of light from that part of the spectrum, and if such protection continues for a sufficient period of time, it has the result of sensitising the retina for the reception of light of those wavelengths when the filter is removed. *Per contra*, light of wavelengths not absorbed by the filter being incident on the retina both when the filter is in position and after its removal, the visual sensation which it excites becomes enfeebled by the continued exposure. Accordingly, when the filter is removed, the visual response of the retina to light of the wavelengths for which its sensitivity has been enhanced is far stronger than the continuing response to the other wavelengths and manifests itself vividly to perception. The nature of the picture seen is determined by the part of the spectrum which is absorbed by the colour filters and differs enormously for the different filters employed in the study. The usefulness of the technique for the study of the functioning of the retina over its different areas is thereby vastly enhanced. As in the analogous case of the Haidinger brushes discussed in an earlier chapter, we have to take note of the essentially fugitive nature of the phenomenon. But here, again, this is no obstacle to the study of the effects. For, the image of the retina seen by the observer on removing the colour filter and which fades away is restored and can be examined again and again merely by putting back the filter in front of the eye for a little while and then removing it.

Preparation and Use of the Colour Filters.—From what has been stated above, it will be

evident that the quality of the filters employed is of great importance. This includes especially the complete transparency over the visible spectrum except in a limited region where there is a complete absorption. It is therefore useful to record here how such filters are prepared. Old and unused photographic plates form excellent material for their fabrication. They are first put in a fixing bath in a dark room and kept long enough to completely remove the sensitive material. They are then washed in running tap-water for half an hour to eliminate all traces of the material of the fixing bath. The plates are then taken out and put in a tray containing distilled water and allowed to remain there for the gelatine to become quite soft. This is necessary to enable the gelatine to absorb the colouring material quickly and evenly. A small quantity of the selected water-soluble dye is put into a beaker containing distilled water and stirred well. The solution obtained is then filtered through a clean cloth to remove any undissolved particles and the clear solution poured into a developing dish of appropriate size. The plate is then immersed in the solution of the dye-stuff and by varying the time of such immersion (depending on the particular dye-stuff) the depth of colour taken up by the gelatine can be controlled. Several different shades of colour on different plates can thus be obtained. The dyed plate is then taken out and washed in water quickly and kept aside for drying. The filters thus prepared are labelled and kept arranged in closed boxes for use as and when needed.

From amongst the numerous dye-stuffs available, several were selected after a preliminary examination of the transmission of light by their aqueous solutions. In all, some 30 different dyes were chosen and some 150 colour filters were prepared therefrom. Four, or five, or six different depths of colour were fixed on plates for each dye, as the comparative study of the effects observed with such a sequence of filters was found to be useful and instructive. To examine the spectral transmission by the filters, the most convenient procedure is for the observer to view the first-order diffraction spectrum of the glowing filament in a tubular lamp through a replica grating and the filter held together before his eye, and to notice the effect on the spectrum of removing the filter. The comparison with each other of the filters of different depths of colour made with the same dye can be quickly effected in this fashion.

For an observer to study the results of using the colour filters in the manner explained above, a screen of the kind used for projection work containing a great many small glass spheres embedded in plastic is found to be particularly suitable. Placed facing the windows in a well-lighted room, such a screen is quite brilliant and this indeed is necessary for any impressive phenomena to be observed. With a screen 175 cm. × 120 cm. in area, 350 cm. is a convenient distance from the screen for the observer to station himself. The area of the screen under observation is then of sufficient width to include an enlarged picture of an extensive region of the retina. That what the observer notices when the filter is removed is a picture of his own retina becomes evident when it is remarked that the foveal disk is the central feature seen in every case. This is located at and around the point on the screen at which the observer's attention is fixed at the instant of withdrawing the filter from before his eye.

We shall proceed to describe one after another the effects observed with the filters prepared with various individual dyes and their relation to the spectral characteristics of the filter. The integrated picture of the retina which emerges from these studies will form the subject of the next chapter.

Filters of Crystal Violet.—Colour filters prepared with this dye exhibit quite spectacular effects. Extremely conspicuous is the brilliant disk of green colour appearing at the centre of the field around the point of fixation of vision at the instant of removal of the filter. Its position as well as the actual size of the disk show it to be a highly enlarged image of the fovea of the observer's own retina. At the centre of the disk a bright spot can be seen which is evidently the foveola, in other words, the bottom of the foveal depression in the retina. The foveal disk also exhibits a rim which is distinctly brighter than the region inside. There are also indications of a radial structure visible within the area of the disk. Outside the foveal disk and concentric with it, the observer notices an extensive area of circular shape of which the diameter is some five times greater than that of the foveal disk, but which is much less luminous than the latter. This area exhibits a greenish-yellow colour, much less saturated in hue than the green of the foveal disk. The outer margin of this area appears fairly well-defined. Beyond this circular area and sur-

rounding it is a region exhibiting an orange-yellow colour.

A sketch of the effects described above is reproduced as Fig. 1. The differences in colour and luminosity between the foveal disk and the surrounding areas cannot, of course, be properly exhibited by shading in a black and white sketch. Even the details of the structures seen visually within the foveal area cannot thus be exhibited. Nevertheless, the figure may help to convey some idea of the effects observed, supplementing a purely verbal description.
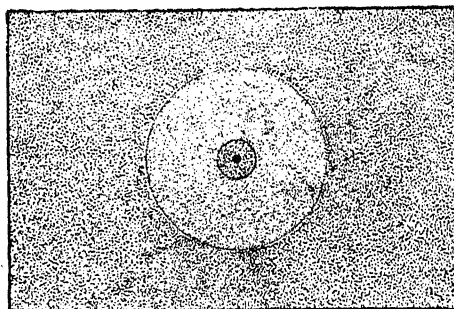
FIG. 1.   Foveal Disk and Surrounding Areas

All the five filters prepared with crystal violet exhibit a blue colour by transmitted light, but the depths of their colours are very different. The effects described above are shown only by those filters which had been dyed to a sufficient depth of colour to make the absorption by crystal violet really effective. Only in three out of the five filters which were prepared was this actually the case. Spectroscopic examination shows that the absorption by the dye manifests itself as two distinct bands, one in the green and the other in the orange, the former ranging from 540 mμ to 570 mμ, and the latter from 590 mμ to 620 mμ. In the most heavily-dyed filter, these bands have spread out and their overlap results in a complete cut-off of the region of wavelengths between 530 mμ and 640 mμ, while the rest of the spectrum is transmitted without any noticeable absorption. In the two less heavily-dyed filters the two bands can be seen to be distinct from each other, but nevertheless the absorption of the yellow in the wavelength range between 570 mμ and 590 mμ is quite strong. The absorption of the yellow is however quite weak in the fourth filter of the series and scarcely noticeable in the fifth.

A comparative study of the effects observed with all the five filters is highly instructive when considered in relation to their respective spectroscopic behaviours. Even with the most lightly-dyed filter, it is possible for the observer to notice on the illuminated screen a picture of his own retina. But for this to be possible, it is necessary to hold the filter before his eye for a longer period before removing it than in the case of the more highly-coloured filters. In the picture then seen, the orange-yellow field in the outer region is the most conspicuous feature, while the circular area and the foveal disk which it surrounds are scarcely noticeable. But these features appear more distinctly with the next filter in the series, while with the three other filters, they become progressively more and more conspicuous.

From what has been stated above, it is apparent that the absorption of light by the filters in the yellow region of the spectrum, *viz.*, between 570 mμ and 590 mμ, plays a highly important role in giving rise to the observed effects. Indeed, only when such absorption is present do we observe the very striking manifestation of a brilliantly luminous disk in the foveal area. That the disk appears of a green colour and not just yellow is an indication that the absorption by the filter of the spectral region between 540 mμ and 570 mμ also then takes part in exciting the foveal region of the retina. The co-operation of the entire region of the spectrum between 540 mμ and 590 mμ is clearly needed for observing the brilliant foveal disk as well as the much larger circular area which appears surrounding it. On the other hand, the absorption of the part of the spectrum between 590 mμ and 640 mμ gives rise to the orange-yellow hue observed in the outer parts in the field. Its effect on the region of the fovea and the area immediately surrounding the fovea is submerged in the much larger contributions arising from the spectral region between 540 mμ and 590 mμ.

Filters of Methyl Violet.—This well-known dye-stuff is closely related to crystal violet in its chemical constitution and its spectroscopic behaviour also resembles that of crystal violet. It is, however, not very easy with it to prepare a set of colour filters of the same high quality as with crystal violet. This may be due to impurities present in the commercially available material. Nevertheless, the filters actually prepared with it which have the necessary depth of colour exhibit effects similar to those observed with crystal violet and approaching them in their spectacular character. The most

striking results are those observed with filters which show a complete extinction in the spectral range between 540 mμ and 630 mμ and perfect transmission in other parts of the spectrum. Thus, they support the same conclusions as those based on the observations made with crystal violet.

Cyanin Filters.—A set of six filters were prepared with this well-known dye-stuff, their colours by transmitted light ranging from a deep blue to a light blue. The absorption spectra of the filters showed a regular progression, the deepest filter exhibiting a practically complete extinction of the yellow, orange and red regions in the spectrum, while the lightest filter showed a well-defined absorption band in the wavelength range from 630 mμ to 670 mμ. The visual effects produced and observed with these filters also alter in a progressive fashion. With the filter which exhibits a cut-off extending from the yellow towards greater wavelengths, the observer notices a disk of yellow light with a bright spot at the centre and a bright rim around its margin appearing in the foveal region. Surrounding this and exhibiting a yellow colour, a circular area also manifests itself which has a diameter some three times greater than that of the foveal disk. Outside this again, there is a field of light extending to the outer limits of the screen and exhibiting an orange hue.

Observations with the other five filters show that the yellow foveal disk and the surrounding yellow region become less and less prominent in the series relatively to the outer parts of the field. With the two lightest filters, they can be observed only with some difficulty. On the other hand, the outermost areas continue to be visible and to exhibit colour. This colour shows a perceptible change from an orange to a reddish hue in the sequence.

From these observations, we are led to infer that the foveal region and the brighter area immediately surrounding it are made conspicuous by reason of light in the spectral range between 570 mμ and 590 mμ being incident on the retina. On the other hand, the orange and the red sectors of the spectrum are responsible for the luminosity appearing in the outer parts of the field.

Filters of Disulphine Blue V.S.—Five filters were prepared with this commercially available dye-stuff. The first two gave a complete extinction of the yellow region of the spectrum and of all greater wavelengths. The absorption

in the yellow was very weak with the third filter and non-existent with the fourth and the fifth. These three filters exhibited a powerful absorption in the orange and red sectors of the spectrum, a dark band in the wavelength range between 630 mμ and 670 mμ being a conspicuous feature.

With the two filters which gave a perfect extinction of the yellow, observations showed the foveal region as bright yellow disk with a luminous spot at the centre and a bright rim around the margin. Surrounding this was a circular region which was less luminous and had a diameter some three times greater than that of the foveal disk. The rest of the field exhibited an orange-red glow. Only the latter phenomenon was exhibited by the three weaker filters, barely a trace of the foveal disk and of the surrounding region being distinguishable from the rest of the field. Thus, the observations point to conclusions similar to those indicated by the observations with the cyanin filters.

Colour Filters of Magenta.—A set of three filters were prepared with this well-known dye-stuff. All three showed a strong absorption in the wavelength range from 550 mμ to 580 mμ, accompanied by a weaker and more diffuse absorption in the wavelength range between 500 mμ and 550 mμ, while the rest of the spectrum showed no observable diminution of intensity in its passage through the filter. In effect, the most heavily-dyed filter cut off the whole of the green in the spectrum, while the other two filters were less effective in this respect.

All the three filters behaved similarly when held by the observer before his eye and then quickly removed while he continues to view the illuminated screen with his attention fixed at a particular point in it. The only difference noticeable as between them is that the less strongly-dyed filters have to be held before the eye for a longer interval of time before being removed. Following the removal of the filter, the entire area of the screen exhibits a greenish-yellow glow which vanishes after a few seconds. But it may be instantly restored by putting back the filter and then removing it again. In effect, the observer sees on the screen a projection of his own retina as illuminated by light in the wavelength range between 550 mμ and 580 mμ. This is made evident by the appearance at the centre of the field of a disk which does not exhibit the greenish-yellow glow seen over the rest of the screen and which is differentiated

from the surrounding area by its relative feebleness and its pale blue colour.

From the foregoing, it emerges that the effects observed with the magenta filters are strikingly different from those exhibited by the other filters and described in the preceding paragraphs. These differences are clearly attributable to the regions of the spectrum exciting the response of the retina being different. It may be remarked that in the present case, we are concerned exclusively with the response of the retina to light appearing in the green sector of the spectrum.

Colour Filters of Rhodamine B.—Four filters were prepared with this well-known dye by varying the time of immersion of the gelatine film in the bath of its solution. The depth of the colour exhibited by them in transmitted light showed the progressive change to be expected in the circumstances. Even the most lightly-dyed filter shows a complete extinction of light in the wavelength range between 540 mμ and 580 mμ. In the more heavily-dyed filters, this absorption band widens asymmetrically towards shorter wavelengths, resulting in a complete extinction of the green region in the spectrum. A spread of the absorption towards longer wavelengths in the more heavily-dyed filters is also noticeable, but the yellow and orange of the spectrum are not totally extinguished. Thus the effect of the rhodamine filters is principally to block out the green of the spectrum. The phenomena observed with them are essentially similar to those noticed with the magenta filters. It is therefore unnecessary to describe them here again in detail.

Yellow Colour Filters.—Various dyes when incorporated into gelatine films result in filters exhibiting a yellow colour by transmitted light. Auramine-yellow may be mentioned as a good example of such a dye-stuff. Spectroscopic examination shows that when the absorption is confined to the extreme violet end of the spectrum, the colour of the transmitted light is a pale yellow. As it progresses further and covers more of the spectrum, the colour deepens. Finally it becomes a rich golden yellow when all wavelengths less than 500 mμ have been cut off. A further advance into the green of the spectrum beyond 500 mμ results in the transmitted light exhibiting orange-yellow hues.
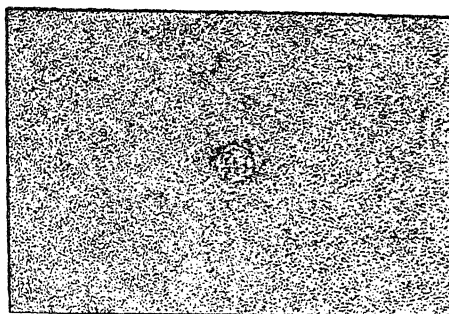
FIG. 2. Foveal Disk and Surrounding Area.

Observations made with all such filters exhibit certain common features. Following the removal of the filter from before the observer's eye, a glow of colour appears over the illuminated screen, its brilliance depending notably on the depth of colour of the filter as also on the period of time for which the filter is held before the eye prior to its removal. The colour of the glow ranges from violet to blue or a bluish-white, depending on the extent of the spectral cut-off by the filter employed. At the centre of the field around the point of fixation of his vision, the observer notices a circular area—evidently the projected image of the fovea of his own retina—where the glow referred to above is absent and a pale yellow hue is perceived instead. (Figure 2 attempts to represent this effect by a black and white sketch.) A dark spot is sometimes also seen at the centre of the foveal disk, with some indications of structure within the area.

NEIGHBOURING GROUP PARTICIPATION IN NATURAL PRODUCTS CHEMISTRY

S. S. CHIBBER and T. R. SESHADRI

Department of Chemistry, University of Delhi, Delhi-7

INTRODUCTION

THE rate of reaction and the nature of the products formed when an organic molecule is involved depends to a very large extent on the main structure of the molecule and the groups present in it. These groups can alter the course of a reaction through the operation of inductive, resonance and steric effects individually or through combination. For example, higher dissociation constant of chloroacetic acid as compared to acetic acid is due to the inductive effect of chlorine.[1] p-Nitrophenol is about 600 times as strong an acid as phenol mainly because of resonance effect.[2] Those reactions in which there is a decrease in crowding in going from reactants to products are speeded up and the reactions in which crowding is increased are slowed down. For example the p-nitrobenzoate (I) undergoes solvolysis at a rate much faster than tert. butyl p-nitrobenzoate and this difference is primarily attributed to steric factor.[3] In all such cases the substituent makes the electrons move in one direction or the other and are not directly connected with the reaction centre. Recently considerable attention has been paid to those reactions in which the rate and the course are altered by a neighbouring group which gets directly involved with the reaction centre. This has been found to take place in nucleophilic and electrophilic substitutions as well as in free-radical reactions. The present discussion is however limited only to the first type as this class of reactions has been most extensively studied.

designated as $S_N 1$ and $S_N 2$. $S_N 2$ reactions almost always give products with inversion of configuration and provide satisfactory explanation for Walden Inversion. On the other hand reactions proceeding through $S_N 1$ mechanism normally give racemic products except in some special cases when products with retained configuration are formed. This retention of configuration can be due to two reasons. One reason is the operation of internal nucleophilic substitution mechanism designated as $S_N i$. This is best illustrated by the formation of chlorides from optically active alcohols by thionyl chloride.[4,5] The reaction proceeds through the formation of alkyl chlorosulphite (II) which can be isolated and on heating gives the chloride of retained configuration arising from the cyclic intermediate (III).
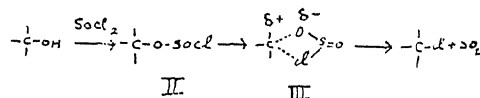
NEIGHBOURING GROUP PARTICIPATION[6-8]

The other reason for the formation of products with retained configuration is the neighbouring group participation. It can be best explained by considering the following example. *trans* 4-Methoxycyclohexyl tosylate (IV) on acetolysis produces acetate with predominant retention of configuration (VI).[9] Participation by methoxyl group produces the cyclic structure (V) in the boat form which is considered to be responsible for the formation of the product with retained configuration as shown below.

I

STERIC ASPECTS OF NUCLEOPHILIC SUBSTITUTION REACTIONS

Substitution by nucleophilic reagents is known to proceed primarily through two pathways
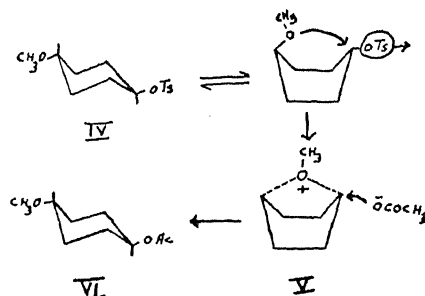
Neighbouring group participation is said to take place when the group gets partially or fully

bonded with the reaction centre in the transition state and this is intramolecular. Groups which have unshared electrons (*e.g.*, —OH, —O-, —OR, —SR, —NR$_2$, —COOR) or groups having π-electrons (*e.g.*, double bond, aryl group) can participate by attacking an electron-deficient centre from the rear, somewhat in the manner of substitution reactions proceeding by S_N mechanism. In most of the reactions of this type the neighbouring group is located behind the carbon atom undergoing substitution and is therefore better posed for attack than if it were a part of a different molecule. In a typical case like (VII) when the group G : participates in the elimination of group 'X' a cyclic transition state[10] (VIII) is obtained which is susceptible to attack at either C$_1$ or C$_2$, thus giving either the product with retained configuration (IX) or the rearranged product (X).
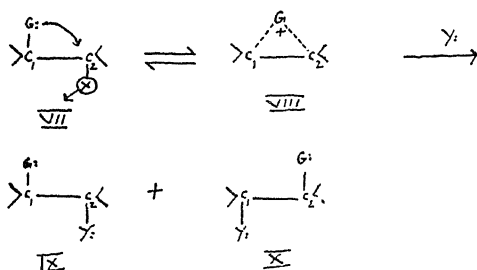
As a result of neighbouring group participation three principal types of results are obtained. Firstly, the rate of reaction is appreciably higher when participation takes place in the rate-determining step as compared to a similar reaction devoid of participation. In such cases the neighbouring group is said to provide 'anchimeric assistance'.[11] For example, acetolysis of 2-methyl-2-phenylpropyl brosylate* (XI) proceeds about 80 times faster than that of isobutyl brosylate (XIII) because of participation by the phenyl group to give phenonium ion[12] (XII). Sometimes the participation takes place after a rate-determining ionisation. In such cases no anchimeric assistance is observed.[13]

Secondly, neighbouring group participation usually has stereochemical consequences, such as the formation of products with retained configuration. This point has already been illustrated by the conversion of (IV) into (VI). Retention of configuration is normally due to attack of 'Y' at C$_2$ in (VIII). When there is effect of neighbouring group participation it

can be inferred that the participating group is so located that it can approach the reaction centre from the rear and thus enable one to distinguish between different steric forms of a molecule. Of the two geometric isomers of 2-chlorocyclohexanol the *trans* isomer (XVI) can be distinguished from the *cis* isomer (XVII) because its rate of reaction with alkali which is about 100 times faster than that of the *cis* isomer.[14]
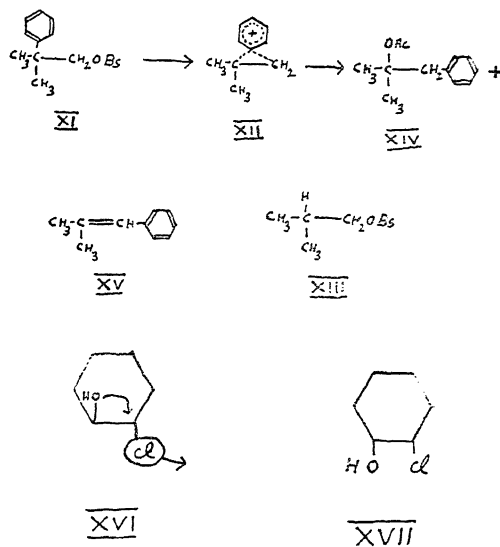
Thirdly, neighbouring group participation quite frequently leads to molecular rearrangement when the participation is strong enough to form a covalent bond with the reaction centre. The rearranged product is formed because of the attack in the transition state by the entering nucleophile at a carbon atom other than the one which loses the substituent, *e.g.*, the attack of 'Y' at C$_1$ in (VIII). This can be exemplified by the conversion of the brosylate (XI) on acetolysis into the rearranged olefin (XV) and the acetate (XIV). Several rearrangements like pinacol-pinacolone rearrangement and Wagner-Meerwein rearrangement are considered to involve neighbouring group participation. Typical examples are discussed later on.

ROLE OF NEIGHBOURING GROUP PARTICIPATION IN THE CHEMISTRY OF NATURAL PRODUCTS

Most of the reactions in the chemistry of natural products have not been studied from the mechanistic point of view. It is therefore difficult to say precisely the mechanism followed but quite frequently analogies are drawn from the reactions

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* Brosylate is the abbreviation for *p*-bromobenzenesulphonate.

of simpler compounds which are not of natural origin. Using analogies drawn from the neighbouring group participation reactions the chemistry of natural products can be provided a new approach. Some applications of this type of reactions to the different aspects of natural product chemistry, *i.e.*, synthesis, biogenesis and rearrangements are discussed below.

Synthesis.—Synthesis of naturally occurring compounds involves two main difficulties. The first is the preparation of either the intermediate or the final compound in a particular steric configuration. This difficulty can be overcome by making use of the steric effects of the neighbouring groups as has been done in the synthesis of sucrose.

Sucrose.—Synthesis of sucrose remained a major problem for more than two decades after its structure was established in 1930. The main difficulty was to obtain $\alpha : \beta$-linking of glucose and fructose units. In ordinary methods of synthesis the opposite configuration is obtained; for example the condensation of the tetraacetyl anomers of glucose and fructose in presence of dehydrating agents yields only isosucrose octaacetate[15] ($\beta : \alpha$-isomer). Lemieux and Huber solved the problem by employing the principle of neighbouring group participation.[16] The important intermediate in the synthesis is the Brigl anhydride (XVIII) which is attacked

by alcohols at C_1 to give glucosides. Simpler alcohols, like methanol and ethanol, give β-glucosides, whereas higher alcohols, like menthol and cholesterol, give mixtures of α- and β-glucosides probably due to the fact that the approach of the higher alcohols to form β-glucosides is sterically hindered. Further, neighbouring group participation as shown in (XIX) also helps considerably in yielding the α-glucosides. Fructose tetraacetate (XX) being also a bulky molecule was expected to react in a way favourable to the formation of α-form. This was in fact realised and the condensation

of Brigl anhydride with tetraacetyl fructofuranose gave sucrose octaacetate (XXI) in a yield of about 9%.

The second difficulty is the preparation of sterically strained products or intermediates. It can be overcome by making use of the driving force associated with neighbouring group participation. This is exemplified by the synthesis of cycloheptenone derivative (XXIII) in the total synthesis of longifolene.

Longifolene.—Though the tricyclic sesquiterpene, longifolene (XXV) was isolated as early as 1920, its structure was established only in 1953 by Moffett and Rogers using X-ray crystallography.[17] The synthesis of this substance also remained a difficult problem after its structural establishment. Of the several key intermediates envisaged by Corey and coworkers the cycloheptenone derivative (XXIII) was considered most suitable. It was synthesised from (XXII) by utilising intramolecular nucleophilic displacement involving π-electron participation.[18] The reaction was carried out by heating at 50° for 60 hours a solution of p-toluenesulphonate (XXII) in tetrahydrofuran saturated with lithium perchlorate containing suspended calcium carbonate. Lithium perchlorate in tetrahydrofuran solution facilitates the ionisation of the tosylate group and thus generates an electron-deficient carbon atom accompanied by the migration of the bond; calcium carbonate prevents the solution from becoming acidic. Under these conditions kinetically favoured cycloheptenone derivative is formed whereas under acidic conditions thermodynamically stable six-membered compounds would result. The cycloheptenone derivative (XXIII) when subjected to intramolecular michael addition gave rise to ketone with the longifolene skeleton (XXIV) which could be converted into longifolene.

Biogenesis.—Nature produces with facility complex organic substances which are quite diffi-

cult to make in the laboratory. The mechanism followed in biosynthetic reactions is not always clearly known, but it is quite likely that neighbouring group participation plays an important role in some of the novel rearrangements encountered. Normally in the laboratory one uses p-toluenesulphonate, p-bromobenzenesulphonate, p-nitrobenzoate, chloride, etc., as the leaving groups but in natural processes phosphate and hydroxide can very effectively serve as the leaving groups[19] and generate an electron-deficient carbon atom which can then receive the intramolecular nucleophilic attack. Such a change probably takes place in the formation of the well-known precursor of C_9 compounds and units, prephenic acid (XXVII) from shikimic acid-5-phosphate (XXVI).[20-22] The condensation of pyruvic acid takes place in the enol form and involves neighbouring group participation. Here the π-electrons of $>C=CH_2$ act as nucleophile and the transition state also involves the endocyclic double bond. The carbon atom attacked is not the one suffering loss of phosphate as found in the previous cases but it is the C_1 which is in conjugation. A similar type of change has been shown to be involved in the biogenesis of thebaine (XXVIII) in *Papavar somniferum* plants.[23-24]

XXVI   XXVII

XXVIII

XXIX   XXX
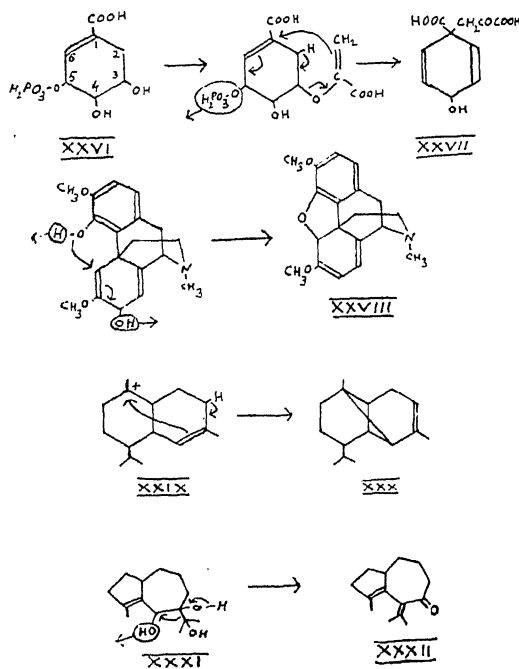
XXXI   XXXII

Biogenesis of terpenes.—Buchi *et al.* have indicated the possibility of formation of copæne

(XXX) from the ion (XXIX).[25] This conversion involves the participation by the double bond. Zierone (XXXII) has been suggested by Barton and co-workers to arise from the compound of the normal skeleton (XXXI) by the changes analogous to pinacol-pinacolone rearrangement.[26]

Biogenesis of isoflavones.—By using labelled precursors like phenylalanine it has been shown that the formation of isoflavone (XXXVI) from chalkone (XXXIII) involves phenyl migration.[27] The exact nature of the intermediates is not known but it is quite likely that a phosphorylated intermediate (XXXV) derived from the dihydroflavonol (XXXIV) which itself can be obtained easily from chalkone (XXXIII) as indicated below, undergoes the change.

XXXIII

XXXIV   XXXV

XXXVI
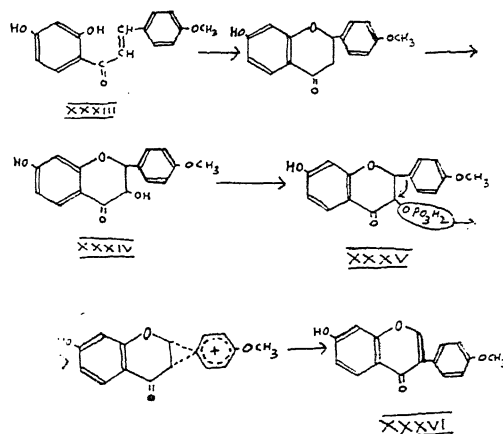
Against the formation of isoflavones from the above hydroxyflavanone it may be argued that the creation of positive charge on carbon atom α- to the carbonyl group is not favoured and therefore such a change could not take place. However, in the change shown above from the phosphorylated intermediate, the transition state involves a non-classical carbonium ion in which the positive charge is spread over the aryl ring.

Similar type of migration has been found to take place in the conversion of tetra-o-methyl-catechin (XXXVII) into the isoflavene (XXXVIII).[28] This system differs from the

XXXVII   XXXVIII
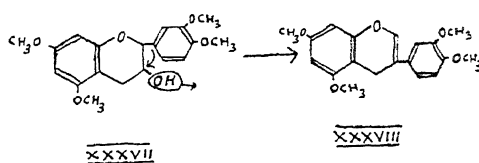
isoflavone system by the absence of the carbonyl group.

A more appropriate example is the formation of isoflavones in the reaction of flavanones with lead tetraacetate. Flavanone (XXXIX a), 7-methoxy flavanone (XXXIX b) and 7 : 4'-dimethoxy flavanone (XXXIX c) yield the corresponding isoflavones (XLI) along with other products on treatment with lead tetraacetate.[29] The first step seems to be the oxidation to form the 3-acetoxy derivative (XL) from which isoflavone seems to arise by aryl migration as shown below.

XXXIX   XL

a; X, Y = H
b; X = OCH₃, Y = H
c; X, Y = OCH₃

XLI
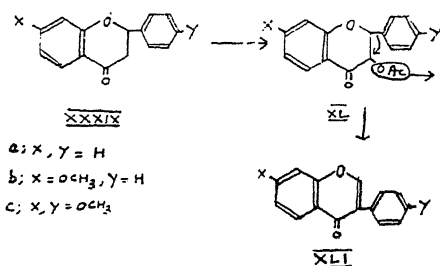
The view that the aryl migration in the above-mentioned cases probably involves neighbouring group participation mechanism is strongly supported by the fact that almost all the isoflavones isolated so far have oxygen functions like —OH, —OCH₃, —O—CH₂—O—, etc., in the ring B. These substituents are known, from the kinetic data and the study of products formed to strongly favour participation by the aryl group. Participation by the phenyl group as such is rather poor as the rate due to the anchimeric assistance by the phenyl group is opposed by its rate-retarding inductive effect.[11] Increased participation by the aryl groups carrying —OCH₃ groups is evident from the fact that 3-p-anisyl-2-butyl brosylate (XLII) suffers acetolysis

XLII   XLIII
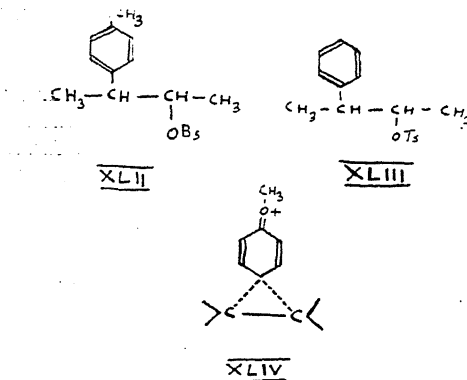
XLIV

about 300 times faster than 3-phenyl-2-butyl tosylate (XLIII).[30] This behaviour of oxygen function is attributed to the stabilisation of the 'phenonium ion' by helping to disperse the positive charge as shown in (XLIV).

SOME TYPICAL REACTIONS OF NATURALLY OCCURRING COMPOUNDS INVOLVING NEIGHBOURING GROUP PARTICIPATION

Compounds of natural origin have been found to give rise to other products, which may or may not be naturally occurring by reactions involving neighbouring group participation. Besides being of preparative importance the participation reactions have also been utilised to acquire some insight into the stereochemistry of the compounds concerned. One comes across a large number of such reactions in the study of terpenoid compounds with the result that some of these reactions of terpenes have been studied in great detail from the mechanistic point of view.

The conversion of camphene hydrochloride (XLV) into isobornyl chloride (XLVII) is a classical example of Wagner-Meerwein rearrangement.[31] Rate of solvolysis of this chloride (XLV) is about 300–800 times faster than ordinary tertiary chlorides. This is attributed to the anchimeric assistance provided by the carbon atom at the 6 position to ionisation at the 2 position resulting in the formation of the non-classical carbonium ion (XLVI).

XLV   XLVI

XLVII
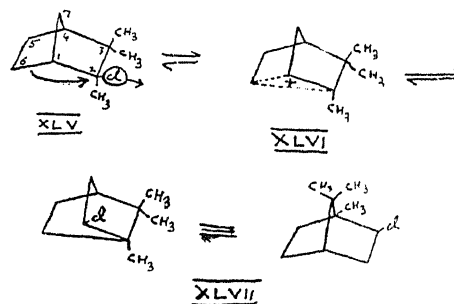
It has been found that under controlled conditions bornyl chloride, isobornyl chloride and camphene hydrochloride can give rise to mainly camphene suggesting that all these interconversions proceed through the ion (XLVI).

Double-bond participation has been reported to be taking place in the solvolysis of cholester-3β-yl tosylate (XLVIII) on the basis of the products formed and its rate of solvolysis which is more than a hundred times faster than the corresponding saturated

compound.[32,33]   The   tosylate   (XLVIII)   on
methanolysis in presence of potassium acetate
yields methyl ether of 3, 5-cyclocholestan-6-ol
(L) (90%) and cholester-3 β-ol.[34] In this case
the non-classical ion (XLIX) is suggested to be
involved because tosylate of 3-hydroxymethyl-
A-norcholest-5-ene (LI) can also give rise to
the ion (XLIX) and has been found to yield
the same solvolytic products.[35]

Recent investigations have shown that simple
conversion of fumaric acid (LII) into malic and
(LIII) involves participation of the carboxy-

late group and the intermediate formation of
the 6-lactone as shown above.[36]

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LETTERS TO THE EDITOR

NUCLEAR QUADRUPOLE RESONANCE OF BR[81] IN SOLIDS

In continuation of the work on Bromine Nuclear Quadrupole Resonance reported earlier,[1] new Br[81] resonances in four compounds are reported in this note.

These resonances have been observed and measured at room temperature using the experimental technique reported previously.[1] The compounds are melted into sample tubes to obtain close packing. Br[79] resonances for all the five compounds and Br[81] resonance for compound (4) have been reported in literature.[1-5]

Br[81] resonance frequencies have also been calculated in the present work using Hammett's σ values[6,7] and the equation

$$f = 9 \cdot 958 \, \sigma + 224 \cdot 25$$

where f is the resonance frequency of Br[81] in megacycles per second and σ is the Hammett's σ value.

The calculated and observed frequencies together with σ values used are given in Table I.

TABLE I

Compound	σ	Resonance frequency of Br[81], Mc/s.	
		Observed	Calculated
1 2, 5-Dibromo-Nitrobenzene	2·262	247·38	246·77
	0·942	232·74	233·63
2 o-Bromo nitro-benzene	2·030	245·85	244·46
3 m-Bromo nitro-benzene	0·710	232·61	231·32
4 p-Bromo aceto-phenone	0·516	226·38 (230·67 at 77°K)[5]	229·39
5 Bromo camphor	..	222·54	..

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Microwave and Magnetic   K. V. S. Rama Rao.
  Resonance Laboratory,   C. R. K. Murty.
Physics Department,
Andhra University,
Waltair, March 8, 1965.

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COMPLEX FORMATION BETWEEN URANYL IONS AND β-RESORCYLIC ACID

THE formation of a deep orange-coloured, water-soluble complex between uranyl ions and β-resorcylic acid with a maximum absorption in the range 454–478 mμ has been observed. The colour attains its maximum intensity at pH 4·2. The composition of the complex has been determined by Job's method,[1] molar-ratio method[2] and slope ratio method[3] employing spectrophotometric data.

Uranyl nitrate used was of A.R. quality. β-resorcylic acid was synthesized from resorcinol by the standard potassium bicarbonate method,[4] recrystallized from water and dried.

The curves of absorbance vs. the wavelength for 1 : 1, 1 : 2 and 1 : 3 ratios of uranium to β-resorcylic acid at pH 4·2 are practically identical in shape and could be superimposed by adding a suitable constant to the ordinates of each curve. This suggests that the reagent forms only one complex in solution with uranyl ions under the condition of the study.

COMPOSITION OF THE COMPLEX

Job's method.—Absorbance values (pH 4·2), when plotted against the ratios of concentrations of uranyl ion to the total concentration of reagent, showed a maximum at the ratio of 0·5, indicating the formation of 1 : 1 complex. Each curve had a broad maximum which is to be expected when there is appreciable dissociation. Harvey and Manning's slope ratio method also suggested the formation of 1 : 1 complex. Molar ratio method also indicated the formation of 1 : 1 complex. On mixing the solution of uranyl nitrate and β-resorcylic acid, pH decreases. This indicates the displacement of
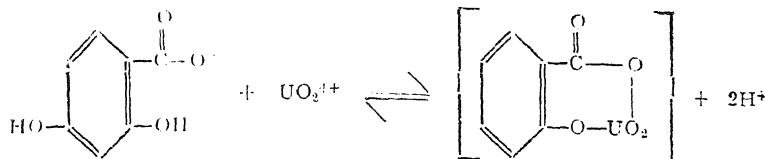
phenolic proton of the resorcylate by the uranyl ion. The reaction can be represented as shown above.

Detailed results will be reported elsewhere. Thanks are due to Prof. B. K. Vaidya for keen interest in the work.

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A POTENTIOMETRIC STUDY OF VANADIUM (IV) AND POTASSIUM FERROCYANIDE REACTION

Amongst the studies of the reaction between potassium ferrocyanide and various metals in different valency states, by physico-chemical methods the reaction between potassium ferrocyanide and vanadium (IV) received no attention. The present communication deals with the potentiometric study of vanadium (IV) ferrocyanide reaction.

Vanadyl sulphate ($0.1 M$) solution was prepared by reducing sodium vanadate solution in sulphuric acid medium with sulphur dioxide, and excess sulphur dioxide was expelled by passing carbon dioxide into hot boiling solution and the resulting vanadyl sulphate solution was standardised against standard potassium permanganate solution at $80°\,C$. The over-all acidity of vanadyl sulphate solution was $2.5\,N$.

Potassium ferrocyanide ($0.1 M$) solution was prepared by dissolving requisite quantity of A.R. potassium ferrocyanide crystals in distilled water. Requisite quantity of potassium ferricyanide was added to this solution to make it 0.1% with respect to potassium ferricyanide. The solution was standardised with standard ceric sulphate using N-phenyl anthranilic acid as indicator.

5 ml. of vanadyl sulphate solution was pipetted out into a 100 ml. beaker and diluted to 60 ml. A bright platinum wire electrode, and a saturated calomel electrode were employed. The potentials were measured by means of a Pye (Jr.) potentiometer. Results are recorded in Table I.

TABLE I

Milli-moles of vanadyl sulphate	Milli-moles of Potassium ferrocyanide	Vanadyl : Potassium ferrocyanide
0.3077	0.1979	3 : 1.93
0.5539	0.3608	3 : 1.95
0.6155	0.4006	3 : 1.95
0.6770	0.4552	3 : 2.02
1.2310	0.8013	3 : 1.95

From the results given in Table I, it is clearly seen that the formula of the complex precipitate corresponds to $K_2(VO^{++})_3[Fe(CN)_6]_2$. A potential break of 100–150 mv. per 0.1 ml. $0.1\,M$ complexing agent was obtained with low acid concentration ($0.2\,N$).

Chemistry Department,   D. Venkata Reddy.
Sri Venkateswara Univ.,   S. Brahmaji Rao.
Tirupati, *November 27, 1964.*

BIS-TETRAMETHYL AMMONIUM TETRACHLORO IRON (II) COMPLEX

In an earlier communication,[1] tetramethyl ammonium tetrachloro iron (III) complex was reported. It was shown to be a spin-free tetrahedral complex using $4s4p^3$ bonding orbitals. In the case of trivalent iron cation. the non-bonding 3d shell has a perfect cubic symmetry since it is half-filled (d^5). As such, it causes least perturbation to the preferred stereochemistry of the molecule. The situation is not the same in case of ferrous complexes due to the presence of one more extra electron (d^6). In this communication, bis-tetramethyl ammonium tetrachloro iron (II) complex $[(CH_3)_4N]_2[FeCl_4]$ is reported.

An alcoholic solution of tetramethyl ammonium chloride ($0.21\,gm.$) was added to an

alcoholic solution of ferrous chloride (0·12 gm.) and well shaken. A light yellow-coloured crystalline compound was formed. Filtered through a glass-sintered funnel, washed with absolute alcohol followed by petroleum ether. Dried the compound *in vacuo*. (Found Fe— 15·2%, Cl—40·6%, $C_8H_{24}N_2FeCl_4$ requires Fe— 16·1%, Cl—41·0%). The compound is not stable in air. It undergoes a change in presence of air and moisture. It is readily soluble in water and the conductance results show it to be a 2 : 1 electrolyte. It decomposes at 280° C. The compound is paramagnetic in solid form indicating four unpaired electrons $\mu_{eff} = 4\cdot9$ B.M.).

Since the electrostatic field produced by the approaching ligands has an effect on the energy of the non-bonding d-shell of the central metal atom, the arrangement of these ligands around the metal atom is determined primarily by this non-bonding d-shell. The shapes of complexes of metal ions possessing spherically symmetrical non-bonding d-shells are well known.[2] The ferric complex[1] and the divalent manganese complex[3] reported by us earlier come under this category due to the presence of a symmetric half-filled d^5 non-bonding shell. The ligand-field theory suggests that for electronic configurations other than d^0, d^2, d^5, d^7 and d^{10}, a regular tetrahedral arrangement is much less probable than an octahedral, tetragonal or square planar one. Thus four covalent divalent Nickel (d^8) and divalent iron (d^6) complexes are not expected to occur and more so in a tetrahedral form. However, after the report of Venanzi,[4] many tetrahedral nickel (II) complexes have been reported in recent years. Many hexa-co-ordinated complexes of divalent iron were known earlier,[5] but the four-covalent compounds are very rare. The compound under report is another example of a tetrahedral Fe (II) complex utilising $4s4p^3$ bonding orbitals.

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ISOLATION OF RUTIN FROM THE FLOWERS OF *CLEOME CHELIDONII* LINN.

ABOUT 12 species of *Cleome* Linn. (Capparidaceæ) are recorded[1] to occur in India and *Cleome chelidonii* Linn. (*Polanisia chelidonii* DC.) is a common plant growing in and around Pondicherry and valued as a green manure in this locality. In continuation of our earlier work[2,3] on the survey of South Indian plants for flavonoids known to have definite pharmacological properties and potential use as anti-oxidants, we have chemically examined the flowers of *C. chelidonii* on which no earlier study has been recorded, and our results are briefly given below :

Fresh flowers of *C. chelidonii* collected around Pondicherry during September 1964 were extracted with methanol twice by cold maceration and then once in the hot under reflux. The combined extract was concentrated *in vacuo* to remove all the organic solvent and the aqueous concentrate was shaken with petroleum ether and ether in succession to remove some wax and free flavonol (quercetin) respectively. To the aqueous layer was added an equal volume of ether and the mixture left in an ice-chest for a week, when pale yellow crystalline solid giving characteristic tests of a flavonol glycoside was obtained. This was filtered, washed with peroxide-free ether and purified by recrystallisation twice from aqueous methanol, when pale yellow needles, m.p. 186–88° (decomp.) were obtained (yield, 3·1% on dry basis). On paper chromatography, the compound was found to be a single entity and the Rf values (31° C.) in different solvent systems [ascending : 0·48 (phenol saturated with water), 0·52 (*n*-butanol : acetic acid : water = 4 : 1 : 5), 0·76 (60 per cent acetic acid), 0·53 (15 per cent acetic acid), 0·32 (distilled water), 0·78 (acetic acid : water : HCl = 30 : 10 : 3); circular : 0·63 (phenol saturated with water), 0·78 (water saturated with phenol) and 0·56 (*n*-butanol saturated with water)] agreed with those reported earlier for rutin. The compound answered all the characteristic colour reactions of rutin and on hydrolysis with 2 per cent sulphuric acid in aqueous methanol (1 : 1) for 2 hours, quercetin, m.p. 312–15° and the sugars, glucose and rhamnose were obtained. The identity of the aglycone as quercetin was confirmed by preparing its penta-acetate, m.p. and m.m.p. 194-95°. The sugars were identified as rhamnose and glucose by paper chromatography

and by preparing the osazones, m.p. and m.m.p. 184-85° and 206-7° respectively. The separation of the mixture of osazones was effected by their differential solubility in acetone.

Finally, the identity of the glycoside as rutin was confirmed by comparison of colour reactions, co-chromatography and m.m.p. determination with an authentic sample of the compound. The glycoside was also acetylated using freshly distilled acetic anhydride and fused sodium acetate, when colourless micro-crystalline powder, m.p. 116–18° was obtained.

The present isolation of rutin in 3% yield from the flowers of *C. chelidonii* reported for the first time is significant, since the flowers could be considered a good Indian plant source for rutin, the bioflavonoid used in clinical medicine. Recently, it has also been suggested that rutin with vitamin C may be beneficial in cold tolerance.[4]

It may also be mentioned here that the flower-buds of *C. spinosa* had been earlier reported[5] to contain rutin and the seeds of *C. icosandra* (Syn.: *C. viscosa*) a flavone designated viscosin.[6]

We thank Prof. T. R. Seshadri for his kind interest in this work, Dr. S. B. Rao, Navaratna Pharmaceutical Laboratory, Cochin, for an authentic sample of rutin and Principal Dr. D. J. Reddy for encouragement.

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CHEMICAL COMPOSITION OF *CRESSA CRETICA* LINN. AND *SALICORNIA BRACHIATA* ROXB.

Cressa cretica Linn. (Gujarati : Kardi or Una) is a small branched undershrub growing extensively all over India, especially in Kathiawar, Gujarat and west coast.[1] It is used as a cattle feed and is said to possess a high medicinal value as a tonic, aphrodisiac and expectorant.[2] *Salicornia brachiata* Roxb. (Gujarati : Muchul) is also another shrub growing on saline soils near the seacoast in Gujarat, Kathiawar and west and east coasts of India. It is used in medicine for curing certain types of skin diseases of hairy animals and the ashes are considered to be abortificient, and emmenagogue.[2] It is strongly salty in taste and the young shoots are eaten after pickling. The medicinal and food value of these plants make an analytical study of these worthwhile. The present investigation covers the determination of the mineral constituents including trace elements and organic nitrogen of these plants from Saurashtra region.

The plants *Cressa cretica* and *Salicornia brachiata* were collected in January 1962 from Vallabhipur (Bhavnagar District) and Porbandar respectively. The moisture content was determined by drying the plant material at 110° C. for 4 hr. and the ash content by heating the dried plant material at 550° C. for 3 hr. The air-dried plant material was used for the analysis of water-extractable mineral constituents, trace elements and organic nitrogen and the ash was used for the estimation of water-extractable constituents and complete analysis. The methods adopted for the analysis were given in a previous communication.[3] Organic nitrogen was estimated by Kjeldahl's method from which crude protein was calculated by multiplying by 6·25. Cobalt and iodine were determined by Kidson and Askew's method[4] and by alcoholic potash method[5] respectively.

The moisture and ash contents in air-dried samples of *Cressa cretica* are 8·676% and 13·26% respectively and those of *Salicornia brachiata* are 5·714% and 18·97% respectively.

The water-soluble salts of *Cressa cretica* and *Salicornia brachiata* are 10% and 18·5% respectively of the oven-dried plant material (Table I). Of this 58% in *Cressa cretica* and 86% in *Salicornia brachiata* comprise the two major mineral constituents (*viz.*, sodium and chloride ions). Thus *Salicornia brachiata* contains a high percentage of sodium and chloride ions compared to those present in *Suæda nudiflora*[3] (76·8%), which also grows on saline soils. Further the four major mineral constituents (*viz.*, sodium, potassium, chloride and sulphate ions) are present both in the plant material and in the ash in water-extractable form and hence can be completely recovered from the plant material by treating with water.

TABLE I

Chemical Composition of *Cressa cretica* Linn. and Salicornia brachiata Roxb.

(Values are given in g. per Kg for the major constituents and in mg. per Kg. for minor constituents in terms of oven-dried plant material)

Constituents	*Cressa cretica* Linn.			*Salicornia brachiata* Roxb.			Mineral constituents in	
	Water-extractable mineral constituents in the		Complete analysis of the ash	Water-extractable mineral constituents in the		Complete analysis of the ash	Grasses[6]	Mixed pasture herbage[7]
	Plant material	Ash		Plant material	Ash		(Taken from literature)	
1	2	3	4	5	6	7	8	9
Chloride ..	31·25	31·23	31·26	100·18	100·01	100·03	5	..
Sodium ..	26·85	26·40	25·95	56·75	56·70	56·73	1·3	..
Sulphate ..	24·35	24·46	24·28	7·002	7·003	7·050	..	..
Potassium ..	15·00	15·04	15·03	11·33	11·62	11·57	19·9	..
Carbonate ..	1·515	2·295	16·12	7·160	7·391	13·71	..	..
Calcium ..	0·6492	0 5681	12·84	0·1033	0·3179	4·420	3·7	..
Magnesium ..	0·3279	0·1972	14·43	0·2311	0·6979	2·460	2·4	..
Water-insolubles of the ash			45·41			19·11	..	..
SiO$_2$ ..			5·715			4·729		..
K$_2$O ..			0·1452			0·971		..
Fe$_2$O$_2$* ..			0·1273			0·8541		0·1572 ; 0·0806
Phosphorus* ..			0·2789			1·704	2·1	..
Crude protein*			194·7			69·81		
Minor constituents*								
Manganese ..			57·86			17·83		89·3
Boron ..			12·65			9·870		8·92
Copper ..			9·816			5·680		4·6 ; 13·5
Iodine ..			9·310			Absent	0·05	..
Zinc ..			1·544			22·74		40 ; 56
Cobalt ..			0·454			0·301		0·08 ; 0·14
Arsenic ..			0·010			0·006		

* Determined in the plant material.

The high percentage of water-insoluble residue in the ash of *Cressa cretica* (31%) appears to be due to the presence of large quantities of calcium and magnesium salts compared to those in the ash of *Salicornia brachiata*. The results of complete analysis of the ash show that *Cressa cretica* contains a larger percentage of calcium, magnesium and sulphate ions compared to *Salicornia brachiata*. The crude proteins, as calculated from the values of organic nitrogen, for *Cressa cretica* is fairly high and compares well with that present in grasses (11–27% on air-dried basis). The mineral constituents of the air-dried plant material account for 16·37% in *Cressa cretica* and 21·85% in *Salicornia brachiata* of which 67% of total salts of *Cressa cretica* and 88·6% of *Salicornia brachiata* are water-soluble. Sodium and chloride ions from the major constituents in both the plants,

A comparison of the mineral constituents of these plants with those of grasses and mixed pasture herbages[6,7] indicate that sodium, calcium, magnesium and chloride contents are higher and potassium and phosphate contents are lower than those present in them. Further all the essential micronutrient elements, which are necessary for the growth of plants and animals, are present in large quantities except zinc compared to the amounts present in grasses. The results suggest that these plants can be employed as animal feeds. However, actual feeding trials are necessary to support this view.

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CHROMATOGRAPHIC EXAMINATION OF SUGARS IN THE TUBER OF *PUERARIA TUBEROSA* D.C.

Pueraria tuberosa[1] D.C. (Hindi—Bidarikand, Bilaikand) is a large deciduous climber with woody tuberculated stem, distributed from W. Himalaya to Sikkim, up to 4,000 ft. in Kumaon, lower hills of Punjab, Mt. Abu, hilly tracts of Bengal and South India.

Tuber is sweet in taste and is used[2] in the Indigenous System of Medicine as tonic aphrodiasic, demulcent, alterative, diuretic, etc. It is a predominant ingredient in Chyavanprasha, a popular Ayurvedic tonic.

In chromatographic examination classical descending paper chromatographic technique, with Whatman No. 1 filter-paper and n-butanol : acetic acid : water (4 : 1 : 5) as developing solvent was employed.

A 20 gm. fresh piece of tuber (one-year old) was crushed and treated with petroleum ether to remove the fatty matter. The defatted[3] material was then extracted with 80% (v/v) ethanol and filtered. That filtrate was used in chromatographic separation of free sugars.

The above extract was allowed to flow simultaneously with authentic samples of sugars on the same paper. And since the sugars present in the tuber were not able to be separated during the single flow of the solvent, multiple development technique[4] was applied for clear and distinct separation. The best results were obtained on the fourth development of the chromatogram.

The spots were developed by spraying chromatogram with benzidine ragent[5] (0·5 gm. of benzidine in 10 c.c. of acetic acid and 10 c.c. of 45% trichloracetic acid in 100 c.c. of ethanol and on placing it in an oven at 110° (up to 10 min.). Yellowish-brown and reddish-brown were the colours which developed on the spots. When another chromatogram was developed by equal volumes of 0·2% alcoholic naphthoresorcinol and 2% aqueous trichloracetic acid, only non-reducing sugars developed reddish coloured spots which were not stable.

The comparison of Rf values and visual observation of spots colour revealed presence of sucrose, glucose and fructose in the tuber. Rf values of sugars are as give in Table I.

TABLE I
Rf values of sugars at 10–15° C.

Sugar		Rf
Sucrose	..	·160
Glucose	..	·206
Fructose	..	·265

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EFFECT OF SOIL MOISTURE, NITROGEN AND PHOSPHORUS SUPPLY ON NUTRIENT CONCENTRATION AND ACCUMULATION IN AN UPLAND RICE PLANT

ENYI (1960, 1962) reported that flooding reduced leaf-blade area, length of leaf-sheath and leaf-blade of upland rice varieties.

Enyi (1964) noted that the response of an upland rice, variety Agbede, to the application of nitrogen and phosphorus was less under flooded than under 'dry' soil (80% soil moisture saturation) conditions. The mean reduction in

the total dry weight (root, straw and grain) as a result of the flooding was 57%. The poor growth of the upland rice under flooded soil condition was attributed to lack of aeration which probably reduced the absorption of mineral elements from the soil.

The soil (sandy clay soil) used in this experiment was collected from the College farm. The soil which has a low phosphorus and nitrogen content was thoroughly mixed and the pH brought to 6·0 by liming. A (3 × 3 × 2) factorial experiment with three replications, using an upland rice variety Agbede, was set up in 10 litre plastic buckets, each holding 11 kg. of soil, in the open, and on the College farm, between January and May 1963.

The treatments which were applied to the soil two days before sowing the pregerminated seeds were N1 (1·5 g.), N2 (3·0 g.), N3 (4·5 g.) of

amount of water to be added to the soil in order to maintain this saturation was determined by weighing the pots daily at 8 a.m.

At maturity, *i.e.*, when the grains ripened each plant was dug out and soil washed out of its root system and then dried to constant weight in an electric drying oven maintained at 90° C. Plants from each treatment were bulked together and sub-sample, including the various organs of the plant, was taken and ground in a hand mill for chemical analysis. Nitrogen was determined by Kjeldahl method, potassium was determined by flame photometry while the other nutrients were determined spectrographically by use of a photoelectric spectrometer.*

The effects of soil moisture, nitrogen and phosphorus on the concentration of the mineral elements in the tissue of the plant at harvest are summarised in Table I. Flooding increased

TABLE I

Summary of the mean effects of nitrogen, phosphorus and soil moisture on mineral concentration in the upland rice plant

Nutrients		N_1	N_2	N_3	P_1	P_2	P_3	D	F
						Treatments			
K%	..	1·14	0·92	1·48	1·16	1·17	1·22	0·97	1·38
N%	..	0·573	1·076	1·355	1·010	0·926	1·028	0·707	1·269
P%	..	0·178	0·291	0·195	0·187	0·231	0·247	0·156	0·288
Ca%	..	0·35	0·49	0·40	0·40	0·37	0·46	0·30	0·52
Mg%	..	0·068	0·073	0·071	0·071	0·069	0·073	0·067	0·074
Na ppm.	..	387	401	578	430	467	483	286	584
Mn ppm.	..	53·0	54·3	40·0	48·1	47·5	52·2	50·7	48·8
Zn ppm.	..	102	127	109	94	108	135	101	124
Cu ppm.	..	2·67	6·08	3·99	1·77	1·97	2·65	3·67	4·88
Mo ppm.	..	2·20	2·97	2·42	2·45	2·35	2·78	2·06	3·00
B ppm.	..	18·1	28·9	18·8	20·5	23·6	21·7	14·2	29·7

D = 'Dry' Soil condition ;   F = Flooded Soil condition.

$(NH_4)_2SO_4$ per bucket, P1 (1·0 g.), P2 (2·0 g.), P3 (3·5 g.) of ground superphosphate per bucket. Each bucket received 1·0 g. of K_2SO_4. The fertilizer was thoroughly mixed with the soil. Four pregerminated seeds were sown in each bucket and the seedlings singled fourteen days after sowing.

The treatments that were applied to the soils after singling were 'dry' soil condition (80% soil moisture saturation) (D) and flooded soil condition (F). For the latter treatment water was added to the soil in the bucket until 4 cm. standing water was obtained. This depth was maintained until harvest by daily addition of water at 8 a.m. In the former treatment the amount of water to be added to bring it to 80% soil moisture saturation was determined by the method described by Enyi (1960) and the

the concentration of K, N, P, Ca, Mg, Na, Zn, Cu, Mo and B in the plant. Increasing the nitrogen supply to the plants led to subsequent increase in the concentration of K, N, P, Ca, Mg, Na, Zn, Cu, Mo and B more particularly under the flooded soil condition. Under flooded soil condition the medium and high phosphate application led to the increase in the concentration of K, N, P, Ca, Mg, Na, Mn, Zn, Cu and Mo.

Even though the concentration of most of these elements was higher in plants grown on flooded soil than those grown on 'dry' soil the total content (g./plant) for each of the element was greater in plants grown on the latter than on the former soil conditions (Table II). The percentage reduction in the uptake of the mineral element as a result of the flooding treatment is shown in Table III.

TABLE II

Summary of the mean effects of nitrogen, phosphorus and soil moisture on total nutrient content of an upland rice plant (g./plant)

Nutrients		N_1	N_2	N_3	P_1	P_2	P_3	D	F
K	..	1·21	1·41	2·00	1·51	1·46	1·65	1·92	1·2o
N	..	0·58	1·35	2·03	1·25	1·08	1·31	1·43	1·11
P	..	0·17	0·40	0·28	0·21	0·28	0·32	0·31	0·25
Ca	..	0·33	0·67	0·60	0·46	0·41	0·60	0·60	0·45
Mg	..	0·07	0·11	0·11	0·09	0·09	0·10	0·13	0·06
Na	..	0·04	0·05	0·08	0·05	0·05	0·06	0·057	0·055
Mn	..	0·006	0·008	0·0 6	0·006	0·006	0·007	0·0095	0·0042
Zn	..	0·010	0·020	0·018	0·012	0·014	0·018	0·020	0·011
Cu	..	0·00 25	0·00101	0·00054	0·00023	0·00027	0·00035	0·00057	0·00092
Mo	..	0·00023	0·00042	0·000.7	0·00031	0·00030	0·00036	0·00041	0·00023
B	..	0·0016	0·0040	0·0025	0·0022	0·0030	0·0026	0·0028	0·0025

D = 'Dry' soil condition ;   F = Flooded soil condition.

TABLE III

Percentage reduction in the total content of nutrients because of the flooring treatment

				Nutrients						
K	N	P	Ca	Mg	Na	Mn	Zn	Cu	Mo	B
37	23	20	25	54	4	66	45	44	37	11

In this experiment the mean total dry weight yields (roots, straw and grain) in grams per plant, for the dry soil and the flooding treatments were 197 and 85 respectively. If it is assumed that the efficiency of utilization of the absorbed nutrient for dry matter production is the same for both 'dry' and flooded soil plants the expected final dry matter production by the flooded plants can be calculated for each nutrient. This is shown in Table IV.

TABLE IV

Calculated dry matter production based on total nutrient content of the upland rice grown on flooded soil (g./plant)

				Nutrients						
K	N	P	Ca	Mg	Na	Mn	Zn	Cu	Mo	B
123	153	159	144	91	190	87	108	110	125	176

Total dry matter (g./plant)

The calculated dry matter for each nutrient is higher than that obtained in the experiment, which showed that the efficiency of nutrient utilization for dry matter production was less in plants grown on flooded soil than those grown on 'dry' soil. It is interesting, however, to note that the calculated figures for Mn and Mg are much nearer to that obtained in the experiment. The low absorption of the two nutrients,

therefore, may have been responsible for the low efficiency of utilization of the other nutrients under the flooded soil condition especially as these elements are essential for nitrogen metabolism and photosynthesis in plants. The adverse effect of flooding on dry matter production in upland rice variety may be attributed therefore to the deficiency of Mn and Mg, low efficiency of nutrient utilization and the reduced uptake of nutrients by the plants.

With regard to the effect of N and P on nutrient uptake, increasing the application of both nutrients led to an increase in the final content of all the nutrients studied. In the flooded plants this was due partly to the increase in the concentration of the nutrients and partly to the increase in dry matter. In the dry soil plant it was due mainly to the increase in dry matter.

College of Agriculture,   B. A. C. Enyi.[‡]
University of Nigeria,
Nsukka, E. Nigeria.

* A quantograph as manufactured by Applied Research Laboratories, Glendale, California.

‡ Present address: Department of Agriculture, University of Ibadan, Ibadan. W. Nigeria.

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THE SHILLONG SERIES

THE Pre-Cambrian Sedimentaries in Assam have been termed the *Shillong Series*.[1] A bipartite division of the series has long been recognized. *viz.*, an Upper arenaceous stage and a Lower argillaceous stage.[2] The arenaceous division is composed of a considerable thickness of well-bedded quartzite, locally conglomeratic and frequently micaceous and the argillaceous division of an unknown thickness of highly crumpled and foliated mica schist, hornblende schist, chlorite schist, granulites, amphibolites with occasional bands of shale and slate.[3] Some of the constituent members of the series have been described by Ghosh.[4] But the sequence of the beds has not so far been worked out. Working in the gold-bearing area of Pre-Cambrian exposure west of Mawphlang (91° 45′ 30″ : 25° 27′ 0″) early this year we were able to construct the stratigraphy laid bare over a distance of 10 miles (from Mile post 14 to Mile post 24) on the Mawphlang-Mawsynram (91° 35′ 0″ : 25° 18′ 0″) road. Beyond Mile post 24 the series is truncated by the intrusion of a granodiorite of younger Pre-Cambrian age.

To the south, east and west the argillaceous stage is intruded by a granodiorite of the following composition :

(%)			
SiO_2	..	66·65	MgO .. Trace
TiO_2	..	0·88	CaO .. 0·99%
Al_2O_3	..	14·62	Na_2O .. 0·23%
Fe_2O_3	..	5·89	K_2O .. 3·32%
FeO	..	0·20	P_2O_5 .. 0·26%
MnO	..	0·11	CO_2 .. Nil

Directorate of Geology   K. BORDOLOI.
and Mining,   R. QUDDUS.
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TABLE I

Arenaceous stage	..	16. Epidiorite	..
		15. White and buff coloured sheared quartzite	448 m. (approx.)
		14. Reddish-brown sheared quartzite	320 m.
Argillaceous stage	..	13. Khasi greenstone	512 m.
		12. Phyllite	192 m.
		11. Chloritoid schist	1092 m.
		10. Granetiferous mica schist	320 m.
		9. Chloritoid schist	640 m.
		8. Garnetiferous biotite muscovite schist	256 m.
		7. Banded biotite andalusite gneiss	30 m.
		6. Epidote actinolite quartz rock	450 m.
		5. Calc. schist (gold bearing)	350 m.
		4. Carbon slate	300 m.
		3. Biotite cordierite sillimanite muscovite schist	500 m.
		2. Banded biotite andalusite quartz gneiss	80 m.
		1. Biotite gneiss	230 m.
		(Intrusive granodiorite)	

The sequence observed in the section is given in Table I.

The argillaceous beds dip south-east at angles varying from 70° to 85°. The arenaceous beds also dip in the same direction but the amount of dip varies from 45° to 55°. No conglomerate was seen at the junction of the two stages but at the Beadon falls 18·5 Km. east of Mawphlang, the arenaceous beds are underlain by a graded boulder bed about 61 m. thick. The quartzites here are greatly sheared and show incipient cataclastic texture.

POIKILITIC OLIVINE DOLERITE DYKE FROM KUSHALNAGAR (MYSORE STATE)

AN olivine dolerite dyke occurs near Kushalnagar, Coorg District (N. 12° 26′ ; E. 75° 59′ 30″), at about 150′ N. 74° E. of 133 milestone on the Mangalore-Mysore Road. The dyke occurs as bouldery exposure trending in a direction N. 58° W., and runs for about a mile, with an average width of about 40′, amidst granitic soil.

In hand specimen the dyke rock is dark grey, compact and hard, with a specific gravity of

3·12. The rock shows the presence of large lustrous plates of plagioclase feldspar enclosing euhedral grains of pyroxene and rounded grains of olivine.

In thin section the rock exhibits a typical coarse-grained poikilitic texture (Fig. 1); large
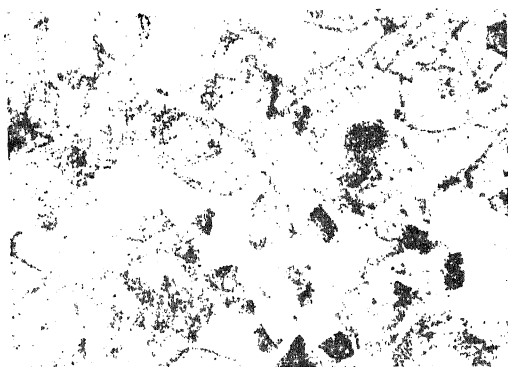
FIG. 1. Larger plates of plagioclase enclosing smaller euhedral augite and subhedral olivine. Ordinary light, × 20.

twinned plates of plagioclase feldspar enclose within them abundant euhedral and subhedral grains of pyroxene and rounded grains of olivine. Occasionally olivine is enclosed within large plates of pyroxene. Besides, small amount of iron ore mostly as magnetite and a few flakes of biotite mica are seen as accessories.

The plagioclase feldspars are optically biaxial negative with −2 V varying from 79° 90°. The twin laws of plagioclase feldspars have been determined on the Fedorov's 4-Axes Universal Stage, according to Reinhard's method (Naidu, 1958). Of the 22 grains studied, 12 gave Albite law, 7 exhibited Manebach, 2 revealed Complex Manebach-Ala—Acline, Pericline and complex Albite-Ala one each. The anorthite content varies from 27–35% indicating the feldspar to be andesine.

Pyroxene occurs as tabular and prismatic crystals having two sets of cleavages intersecting at 90°. Simple contact twins on (100) are common, and polysynthetic twins (parallel to 100) are occasionally observed. It is optically biaxial positive. +2 V ranging from 46°–47°, Z ∧ c ≏ 22°, and birefringence 0·025 (using Berek Compensator). The optical characters indicate that the pyroxene is augite.

Olivine occurs as rounded as well as irregular grains often enclosed in the poikocrysts of plagioclase feldspars, and sometimes in the prismatic grains of pyroxene. It is pale brown

in colour, biaxially negative, birefringence 0·046 (using Berek Compensator) and −2 V = 74°.

The olivine dolerite, under investigation, has been planimetrically analysed using Shand's integrating stage for its modal composition (Table I). It is observed that it is in close agreement with the dolerite of Closepet described by Suryanarayana (1961).

TABLE I

Modal analysis

Minerals	A	B
Plagioclase Feldspar	43·30	46·03
Pyroxene	39·36	46·69
Olivine	12·60	..
Hypersthene	..	3·23
Biotite Mica	2·11	..
Magnetite	2·63	1·16

A—" Olivine Dolerite"—Kushalnagar.

B—"Kunurite"—Closepet (quoted by Devaraju).

Poikilitic texture in dolerites is not very common, especially the type where plagioclase encloses the mafic minerals. Similar occurrences have been reported by Suryanarayana (1961), Devaraju (1962), and Prasada Rao and Narasimhamurthy (1963) from different parts of Mysore. It is apparent from the present investigation also that the magma which has given rise to the dyke had a few grains of earlier-formed olivine. Due to the upward ascent, the magma gradually cooled, when the separation of pyroxene was activated, which in turn enclosed the earlier-formed olivine. Finally due to further fall of temperature plagioclase feldspar (andesine) started separating, enclosing the early-formed olivine and pyroxene and thus giving rise to poikilitic texture.

The authors are thankful to Prof. M. N. Viswanathiah for his encouragement and valuable suggestions in the preparation of this paper. The junior author wishes to express his thanks to the Council of Scientific and Industrial Research, Delhi, for the award of a fellowship.

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DIPTEROCARPOXYLON TERTIARUM SP. NOV., A NEW FOSSIL WOOD FROM THE TERTIARY OF BURMA

So far only *Dipterocarpoxylon holdeni* Gupta (1935) is known as a fossil wood of the family Dipterocarpaceæ from Burma. However, this fossil wood does not show the anatomical characters of this family (Chowdhury, 1938) and needs further study to ascertain its true relationship.

In 1934, a Rangoon University botanist sent to the late Professor B. Sahni a collection of fossil woods from the Tertiary of Burma. One of these woods is being reported in the present note and assigned to the form genus *Dipterocarpoxylon* Holden emend. Den Berger (1927).

The fossil wood is represented by a small piece of decorticated secondary xylem and shows the following characters:

Wood diffuse-porous (Fig. 1). *Growth rings* absent. *Vessels* mostly large (Fig. 1), sometimes medium-sized, t.d. 135–315 μ, r.d. 150–420 μ, the majority solitary, occasionally paired, 4–6 per sq. mm.; vessel-members 150–600 μ long with truncate or abruptly tailed ends; perforations simple; intervessel pit-pairs not seen; tyloses and black deposits present. *Tracheids* sparse, paratracheal, associated with the parenchyma. *Parenchyma* mostly apotracheal, the paratracheal being scanty; apotracheal paranchyma (Fig. 2) diffuse and diffuse-in-aggregates forming irregular lines in the fibrous tract between the rays; more often several rows of parenchyma cells surround the gum canals forming a thick layer and frequently uniting the parenchyma from neighbouring canals. *Xylem rays* 1–9 seriate, mostly 5–7 cells wide, and 20–150 μ broad, 4–6 per mm. (Fig. 3); ray tissue heterogeneous with rays composed both of upright and procumbent cells; often large or upright cells without any contents are found on the margins of the rays. *Fibres* libriform, thick-walled, non-septate, and polygonal in cross-section. *Gun canals* abundant (Fig. 1), vertical, single or usually in pairs or sometimes in short tangential groups up to 7, embedded in parenchymatous sheath, round to oval, 70–120 μ in diameter.

The characteristic distribution of vertical gum canals and the presence of vasicentric tracheids together with other structural features of the fossil wood at once indicate its affinity with the family Dipterocarpaceæ in which it shows a nearest approach to the genus *Dipterocarpus*.

As the present fossil wood differs from all the known species of *Dipterocarpoxylon* from India (Chowdhury, 1938; Ramanujam, 1955; Ghosh, 1956; Ghosh and Ghosh, 1959; Navale, 1962; Eyde, 1962) and abroad (Stopes, 1912; Krausel, 1922 *a*, 1922 *b*, 1926; Den Berger, 1927; Bancroft,
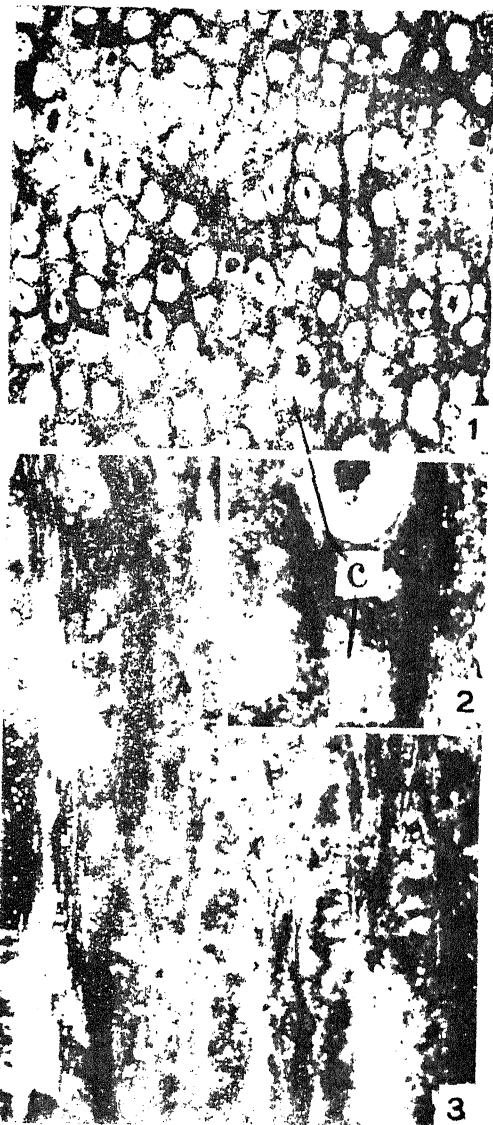
FIGS. 1–3. *Dipterocarpoxylon tertiarum* sp. nov. Fig. 1. Cross-section showing distribution of vessels and gum canals (C), × 15. Fig. 2. Magnified cross-section showing apotracheal parenchyma and gum canals. × 60. Fig. 3. Tangential longitudinal section showing the xylem rays, × 40.

1933; Chiarugi, 1933; Sohweitzer, 1958), it is being described as a new species.

Birbal Sahni Institute of   U. PRAKASH.
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CYTOGEOGRAPHIC STUDIES ON *DISPORUM LESCHENAULTIANUM* DON

HOOKER[1] has described three highly variable species for the genus *Disporum* from India, occurring in the subtropical climatic regions. Two of these, *D. cantonience* Merr. (syn. *D. pullum* Salisb.) and *D. calcaratum* Don., are mainly restricted in the Himalayas and Assam areas and the third, *D. leschenaultianum*, has been localized in the Palni and Nilgiri Hills, the Western Ghats and Ceylon (3,500' to 8,500').

The occurrence of this Himalayan genus in the Peninsular India and Ceylon has been correlated by many authors to the Pleistocene glaciation, which had driven the Northern flora southwards (Burkill[2]: Hora[3]). The genus has survived the post-Pleistocene change of climate by procuring shelter at cool hill tops, and the humid Shola forest cover, in the vicinity of hill streams. It was, therefore, considered worthwhile to initiate comparative cytogenetical studies, with its Himalayan counterparts, so as to ascertain the degree of morphological and cytogenetical divergence, attained by these plants, now evolving in isolation. The present report, however, attempts to describe only the cytological aspect.

The investigations are based on the collections made by the author from a number of places in Nilgiris, Palni Hills in Madras, and Chickmagalur area in Mysore, in July, 1963, and plants obtained from Ceylon. The cytological observations were made from the root-tip squashes, prepared after a prefixative treatment with α-bromonaphthalene for about one hour with subsequent fixation in acetic alcohol (1 : 3) and Feulgen staining.

Numerous well-spread metaphase cell plates have shown the somatic chromosome number $2n = 16$ in all the clones examined. As an illustration, in the clone from Kodaikanal 'DLK' the karyotype consists of 2 pairs and 2 odd long chromosomes with submedian and 3 pairs of medium chromosomes with subterminal primary constrictions and 1 pair of short one with subterminal primary constrictions. A certain degree of structural heterozygosity has been noted in the long chromosomes bearing submedian centromeres (Fig. 1). One pair of SAT chromosomes possessed microsatellites attached to the short arm and associated with 2 nucleoli. The karyotype asymmetry has been indexed as 3 b (Stebbins[4]), based on the ratio between the longest chromosome/shortest chromosome : $22 \cdot 0 / 7 \cdot 0 \mu = 3 \cdot 14$ and the proportion of chromosomes with arm ratio $> 2 : 1 = \cdot 68$.
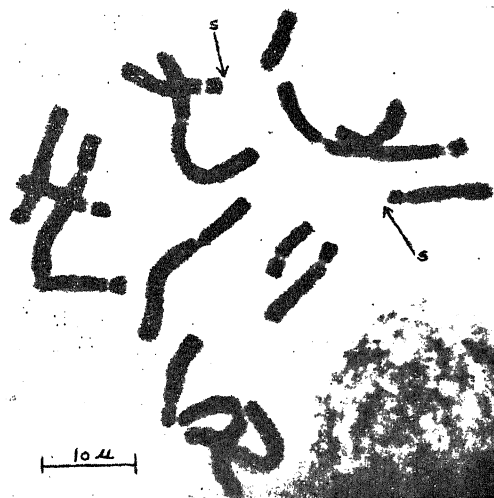
FIG. 1. Metaphase plate from root-tip showing $2n = 16$; ' S ' marks the SAT chromosomes.

The karyotype pattern is in agreement with the Himalayan forms of *D. cantonience* Merr., $2n = 16$ (Mehra and Pathania[5]) and *D. calcaratum*, $2n = 14$ (Kumar[6]), in the presence of a similar SAT chromosome type and karyotype asymmetry index but more specialized in possessing 10 medium and short chromosomes with subterminal centromeres.

It seems likely that the evolution of this species has mainly been at diploid level, by the

repatterning of the genome and gene mutations. The plants seem to be well adapted to live under the newer environmental conditions, by shifts in the morphological as well as physiological features, e.g., the presence of a distinct 'drip tip' leaf, an adaptation to suit the heavy rainfall, a slight reduction in the flower size and the distinctive foliar spur of the Eastern Himalayan forms. The latter is reduced to a small nectar-containing sac-like structure perhaps as an adaptation to the kinds of the pollinating insects available in this comparatively new area of migration. The physiological shift has enhanced its growth period up to December and delayed flowering to June and July. In the Himalayan region, the flowering ends by mid-June and plants start drying by the end of October.

The maximum frequency of its occurrence has been found in Palni and Nilgiri Hills and the adjoining hilly regions in the Western Ghats. It gradually becomes scarce further northward in Western Ghats; it does not occur in Mahabaleshwar (5,000 ft.). Perhaps the atmospheric precipitation has remained the critical factor in determining its range of distribution. Hybridization experiments are in progress to determine the existing chromosomal homologies between the Himalayan and the South Indian taxa.

The author is much obliged to Dr. M. S. Swaminathan (I.A.R.I.), Professor P. Maheshwari (Department of Botany, University of Delhi) and Mr. M. M. Begg (Principal, Delhi College) for their kind suggestions and encouragement. Thanks are also due to Dr. J. P. Correa, UNESCO, New Delhi, and to the Superintendent, Royal Botanic Gardens, Ceylon, for assisting in getting plants from Ceylon, and to the Council of Scientific and Industrial Research, New Delhi, for financial assistance.

Department of Biology, VIRENDRA KUMAR.
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POLLEN GRAINS IN A 'GIGANTIC' PLANT OF *RAUWOLFIA SERPENTINA*

At a village in the Azamgarh District, Uttar Pradesh (India), one of the authors (K. N. Kaul) came across a 'gigantic plant' of *Rauwolfia serpentina*, reaching a height of about 10 ft. (*Curr. Sci.*, 1963, 32, 482). Apart from the tallness of the plant, there was no other striking external features, characteristic of it. The present study relates to its pollen morphology and for purposes of comparison, the study has been extended to the plants of *R. serpentina* grown in the garden of the National Botanic Gardens, Lucknow, which are considered here as 'normal'.

Pollen preparations have been made by the method suggested by Nair,[1] in which 'acetolysed' grains, treated with a mixture of acetic anhydride and conc. sulphuric acid, were mixed with 'unacetolysed' grains in the same slide. The unacetolysed grains alone have been considered for taking the percentage of morphologically sterile (without protoplasmic contents) grains. Pollen counts per anther have been made by the method suggested by Nair and Rastogi.[2]

Pollen grains in *R. serpentina* are 3-colpate. Each colpus is subtended on either side by an elongate hyaline (exine thin) area. The exine is about 2μ thick, and the exine surface is faintly ornamented (Figs. 1-3).
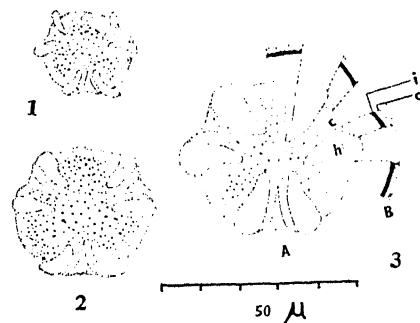
FIGS. 1-3. Pollen grains of *Rauwolfia serpentina*; having the sizes 35μ, 46μ and 59μ respectively (*c*, culpus; *h*, hyaline area subtending the colpus; *st*, exine strata at the colpus region).

The pollen differences between the 'gigantic' and the 'normal' plants have been seen with regard to size and morphological sterility (Fig. 4). Pollen size range is $35-59\mu$ in the 'Normal' and $35-66\mu$ in the 'gigantic'; the percentages of the various sizes (35, 46, 56, 59 and 66μ) vary in the two plant forms. Thus, the 35μ size forms the highest percentage

(33%) in the 'gigantic', corresponding to the 56 μ size forming 48% in the 'normal'. Similarly the highest size of 66 μ occur only in the 'gigantic'.

INDEX

☐ STERILITY

▨ FERTILITY
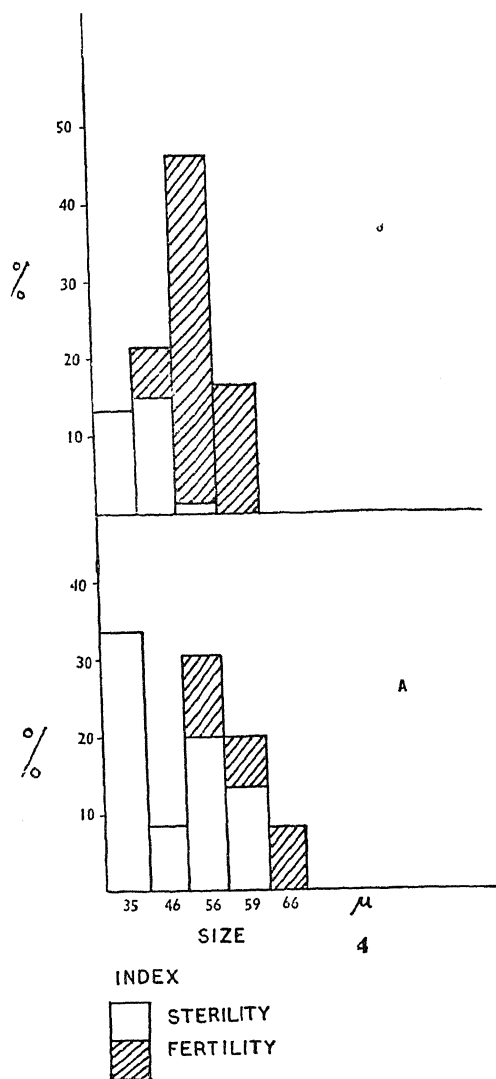
FIG. 4. Histogram showing the percentage of the various pollen size classes and morphological sterility (*see* index) in the 'gigantic' (A) and 'normal' (B) individuals of *Rauwolfia serpentina*.

'Morphologically sterile' grains form 29% in the 'normal' and 76% in the 'gigantic'. There is an apparent correlation between the pollen size and morphological sterility. In the 35 μ size, all grains are sterile (in both plant forms), and the sterility shows a gradual decrease in percentage as the size increases (all grains in the 59 μ size of 'normal' and 66 μ size of 'gigantic'

are 'fertile'). Pollen production per anther is 483 in the 'normal' and 162 in the 'gigantic'.

The 'gigantic' plant of *Rauwolfia serpentina* from Azamgarh is distinctive by its tallness, and also pollen characters such as (*i*) large size of a certain percentage (8%) of the grains; (*ii*) the high percentage of sterility (76%) and (*iii*) the low pollen production. The high pollen sterility, and the larger size may perhaps offer evidence to infer the polyploid nature of the 'gigantic' plant. The decrease in the percentage of sterility with the increase in pollen size may be considered to be of significance.

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THREE NEW FOLIICOLOUS FUNGI

IN the course of their study of leaf-spot diseases of Allahabad and adjacent regions, the authors came across with three foliicolous fungi, *viz.*, a species of *Sirodesmium*, another of *Phoma* and a third of *Phyllosticta*. Amongst all the known species of *Sirodesmium*, the present isolate showed some similarity with *Sirodesmium diversum* (Cooke) Hughes. Hughes (1952)[1] proposed this new combination for *Tarula diversa* Cooke following the creation of genus *Sirodesmium* by de Not. (1863).[2] He considered *T. diversa* to be cogeneric with the type species of *Sirodesmium*, *S. granulosum*. In spite of the similarity of the present isolate with *S. diversum*, it could not be accommodated in that because of some pronounced differences and thus a new species of the genus is proposed here.

The morphological characters of the species of *Phyllosticta* and *Phoma* were studied in detail and were compared with those of other known species but they could not be matched with any species so far recorded. They are, therefore, presented here as new species.

Sirodesmium indica CHANDRA AND TANDON

Black cushion-like growth, creeping branched hyphæ, brown in colour; conidiophores dark, bearing terminal chains of conidia borne in simple or branched chains, frequently entire branches of mycelium developing into simple or branched chains of conidia; conidia dark brown, globose to subglobose, thick-walled, warted, diameter 5·2–18·4 μ, septate, mostly didymospores, rarely amerospores or two and

three septate phragmospores and dictyospores (Fig. 2), conidia mature basipetally.

On leaves of *Agave americana* L., Alfred Park, Allahabad, India, August 1963, leg. Sudhir Chandra.

The type specimen has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew No. 102519.

Sirodesmium indica CHANDRA AND TANDON

Nigrum pulvinatum, hyphæ repentes ramosæ, brunneæ; conidiophora fusca, supportantia catenas terminales conidiorum; conidia in catenis simplicibus vel furcatis, sæpe ramis integris mycelii evolventibus in catenas simplices vel furcatas conidiorum; conidia fusce brunnea, globosa vel subglobosa, parietibus crassis, verrucosa, $5 \cdot 2$–$18 \cdot 4\,\mu$ diam., septata, vulgo didymospora, rarius amerospora, vel 2–3 septata phragmospora et dictyospora; conidia maturant basipete.

In foliis *Agaves americanæ* L., in horto alfred, ad Allahabad, mense augusto 1963, leg S. C. Typus positus in herbario Instituti Mycologici ad Kew sub numero 102519.

Phoma garflorida CHANDRA AND TANDON

Symptoms of the disease.—The disease first appears on the upper surface of the leaf as small Pale vinaceous-fawn coloured spots with a sharp outline. Spots are usually circular in the beginning but as they increase in size they assume irregular shape. Mature spots have light Vinaceous-fawn colour and are bounded by a well-defined narrow marginal ring of Metal brown or Army brown colour. At maturity pycnidia appear as small black dots throughout the spotted part of the leaf. The reverse side of a mature spot shows an Avellaneous or Wood brown colour. Spots may occupy any position on the leaf and may freely traverse the midrib or vein.

Morphological characters.—Pycnidia covered by epidermis, later erumpent, membranous, globose or subglobose, single or subgregarious, generally in groups of two to three, with a distinct ostiole, not beaked but papillate, light brown in colour, 120–150 μ (average 170 μ) in diameter (Fig. 4); texture of the pycnidial wall thin, parenchymatous, subtranslucent, formed of one layer of brown polyhedral cells; conidiophores short; spores one-celled, hyaline, majority cylindrical, few ovate, 2–$6 \cdot 2 \times 1 \cdot 5$–$2\,\mu$ (average $4 \cdot 1 \times 1 \cdot 6\,\mu$).

Mycelium light brown, up to $6 \cdot 4\,\mu$ in thickness, closely septate, slightly constricted at septa; chlamydospores rarely seen.

On living leaves of *Gardenia florida* L., Alfred Park, Allahabad, India, October 1963, leg. Sudhir Chandra.

The type specimen has been deposited in the Herbarium of the Commonwealth Mycological Institute, Kew, No. 105630.

Pycnidia operta epidermide postea erumpentia, membranacea, globosa vel subglobosa, singula vel subgregaria, vulgo bina ternave, ostiolo distincto, non-rostrata sed breviter papillata, pallide brunnea, 120–250 μ (mediet. 170 μ) diam.; textus parietum pycnidialium tenuis, parenchymaticus, subtranslucidus; conidiophora brevia; sporæ unicellulares, hyalinæ, quarum plurimæ cylindricæ, nonnullæ ovatæ, 2–$6 \cdot 2 \times 1 \cdot 5$–$2\,\mu$ (mediet. $4 \cdot 1 \times 1 \cdot 6\,\mu$).

Mycelium pallide brunneum, ad $6 \cdot 4\,\mu$ crassum, arcte septatum, aliquantum constrictum ad septa; chlamydosporæ raro notatæ.

In foliis *Gardeniæ floridæ* in horto Alfred, ad Allahabad, mense octobri 1963, leg S. C. Typus positus in herbario Instituti Mycologici ad Kew, sub numero 105630.

Phyllosticta halduana CHANDRA AND TANDON

Symptoms of the Disease.—The disease starts as small Buff pink coloured spots at any place on the leaf-blade. The spots rapidly increase in size and with their increase the centre assumes Vinaceous tawny colour. The mature spots are surrounded by a peripheral zone of Pecan brown or Buff pink colour. Coalescence of spot is very rarely seen. In severely infected leaf the spot covers a major area of the lamina showing one or two big spots which frequently include a portion of the margin.

Morphological characters.—Pycnidia brown, generally separate, sometimes in groups of two to three, at first covered by epidermis afterwards erumpent and projecting, occasionally enclosed by a translucent covering, 150–250 μ (average 240 μ) in diameter; ostiolate with prominent broad papilla, papilla provided with well-defined brown hairs (Fig. 3); texture of pycnidial wall parenchymatous, cells of the wall polygonal, 6–10 μ in diameter; conidiophores short; conidia one-celled, hyaline, cylindrical, 2–$6 \cdot 5 \times 1$–$2\,\mu$ (average $4 \times 1 \cdot 5\,\mu$).

Mycelium hyaline or light brown, generally thin with distinct septa, up to $5 \cdot 2\,\mu$ in thickness; many pseudopycnidia also formed, pseudopycnidia black, globose to subglobose or elongated, translucent, plectenchymatous, 120–330 μ (average 260 μ).

On living leaves of *Adina cordifolia* Hook. f., Govt. House, Allahabad, India, November 1963, leg. Sudhir Chandra.

The type specimen has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew, No. 103807.

6–10 μ diam.; conidiophora brevia; conidia unicellularia, hyalina, cylindrica 2–6.5 × 1–2 μ (mediet. 4 × 1.5 μ). Mycelium hyalinum vel
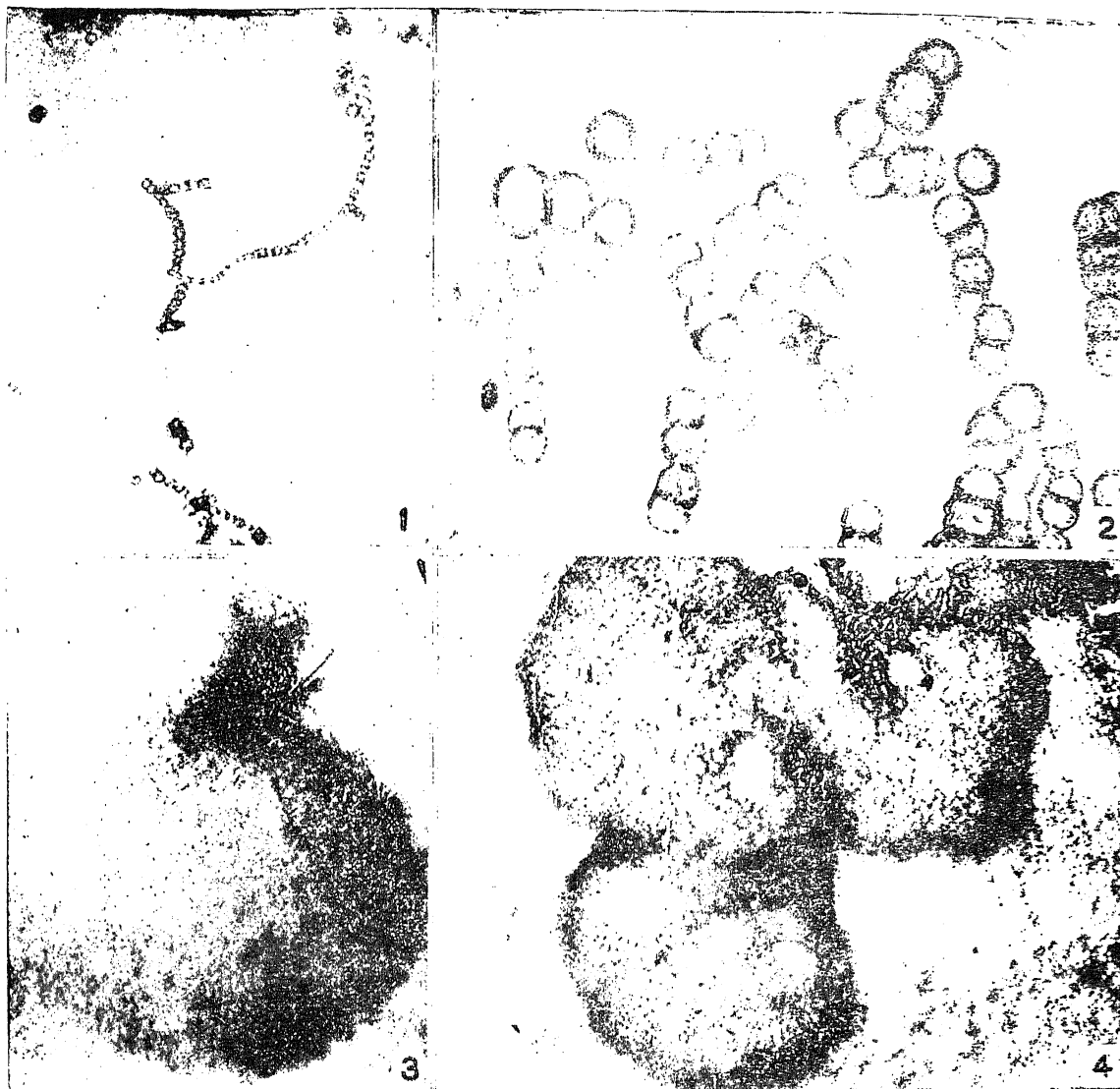
FIGS 1–4. Fig. 1. Conidiophores of *Stroaesmium indica*, × 120. Fig 2. Conidia of *Stroaesmium indica*, × 668. Fig. 3. Pycnidium of *Phyllosticta halduana*, × 200. Fig. 4. Pycnidium of *Phoma garflorida*, × 258.

Phyllosticta halduana TANDON AND CHANDRA

Pycnidia brunnea, vulgo septata, nonnumquam bina ternave, primo epidermide operta, tum erumpentia, interdum circumdata peridio translucido, 150–250 μ (mediet. 240 μ) diam., ostiolatus, ornatus eminenti papilla, quæ ornatur pilis bene definitis brunneis; textus parietum pycnidii parenchymaticus, cellulis polygonalibus,

pallide brunneum, vulgo crassum septis distinctis; pseudopycnidia plurima quoque efformata; pseudopycnidia nigra, globosa vel subglobosa, vel elongata, translucida, plectenchymatica, 120–330 μ (mediet. 260 μ).

In foliis viventibus *Adinœ cordifoliœ*, in Govt. House, ad Allahabad, mense novembri 1963, leg. S.C. Typus positus in herbario Instituti Mycologici ad Kew, sub numero 103807.

Grateful acknowledgement is made to Dr. J. C. F. Hopkins, Dr. M. B. Ellis and Prof. H. Santapau for their kind help.

Plant Pathology Lab.,   SUDHIR CHANDRA.
Botany Department,   R. N. TANDON.
University of Allahabad,
Allahabad, India, *October* 27, 1964.

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STOMATAL ONTOGENY IN SOME ONAGRACEAE AND *TRAPA*

METCALFE AND CHALK[1] mention that the stomata in the Onagraceæ (including *Trapa*) are surrounded by three or more subsidiary cells, sometimes resembling those of the Cruciferæ. As far as I know, their development is unknown. Accordingly, I investigated the stomatal ontogeny in *Epilobium latifolium* Linn., *E. origanifolium* Lamk., *E. palustre* Linn., *Fuschia* sp., *Jussieua repens* Linn., *J. suffruticosa* Linn., *Ludwigia parviflora* Roxb., *Oenothera rosea* Soland. and *Trapa bispinosa* Roxb. The leaves are epistomatic in *Trapa*, hypostomatic in *Fuschia* and amphistomatic in the remaining plants.

Mature epidermal cells in vein meshes of *Trapa* leaves have slightly wavy sides but these are deeply sinuous in all other investigated plants. In *Trapa*, the walls of lower epidermal cells above veins are thinner than those of cells in areas between the veins. Stomata are always evenly scattered. In *Trapa* their orientation tends to be markedly unidirectional and all over parallel to the main veins. Stomata of other plants are irregularly placed in vein meshes although near the main veins they tend to be parallel to them.

Development of stomata in all the plants is in a mixed sequence and essentially of the mesoperigenous type.[2] The first division (Fig. 1) of the stomatal meristemoid gives rise to two unequal cells (Fig. 2): a smaller triangular cell in a corner, which is filled with densely granular cytoplasm and a larger ordinary looking cell. The smaller cell becomes the guard cell mother cell and the larger cell gives rise to one or more neighbouring cells of the mature stoma. Later, the triangular cell becomes rounded and a median wall usually placed at right angles to the first divides it into the two guard cells (Figs. 3, 4). While the latter mature and develop the intervening stomatal pore, their
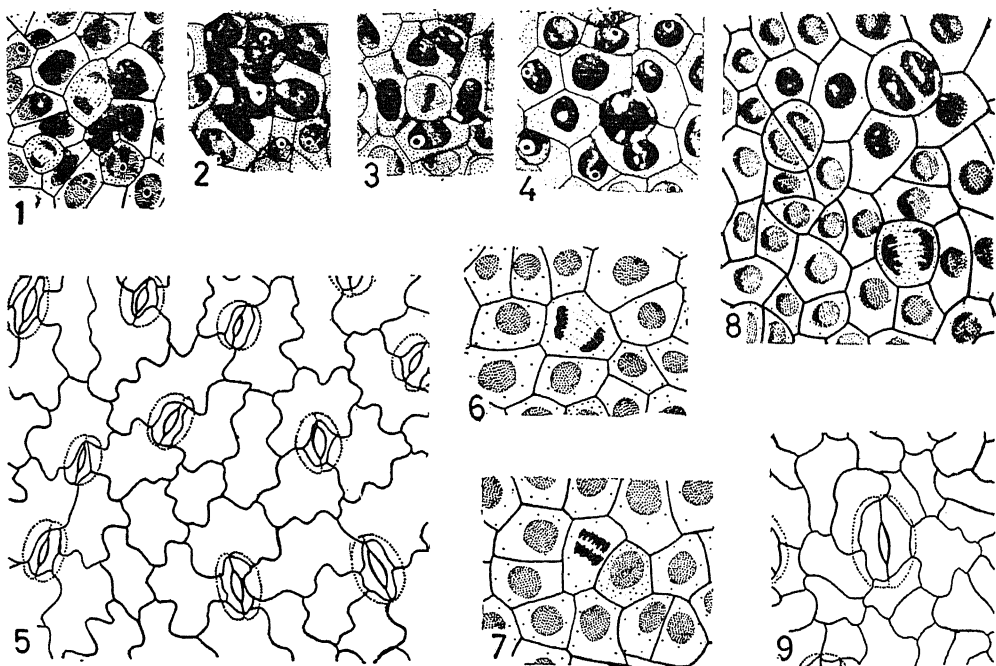
FIGS. 1–9. Figs. 1–5. *Jussieua repens*. Figs. 6–9. *Trapa bispinosa*. Figs. 1–4. Successive developmental stages of typical mesoperigenous stomata, × 880. Fig. 5. Mature epidermis, × 380. Figs. 6–8. Successive developmental stages of stomata, × 1,000. Fig. 9. A mature stoma, × 500.

mesogene and perigene neighbouring cells divide or become so modified in shape and size that the mature stoma appears anomocytic or ranunculaceous (Fig. 5). Such stomata are frequently surrounded by three neighbouring cells but never are these typically anisocytic or cruciferous. Moreover, their development is quite unlike that of anisocytic stomata (*cf. Notonia*[3]).

The first division of the meristemoid in all investigated plants is similar (*see* Fig. 6) but in the stomata of *Trapa*, the second division, which partitions the guard cell mother cell, is deferred till the neighbouring mesogene cell has become indistinguishable (Figs. 7–9). In other plants the mesogene sister cell of the guard cell mother cell can usually be recognized at the time of the second division and occasionally even later. Therefore, the development of stomata in *Trapa* may be taken to verge on the perigenous type.

The above facts are equivocal about the systematic position of *Trapa*. Traditionally included in the Onagraceæ,[4] the genus was isolated by Raimann[5] in a family of its own, the Hydrocaryaceæ. Pulle[6] supported Raimann but changed the family name to Trapaceæ, and Ram[7] pointed out embryological differences between Onagraceæ and *Trapa* to strengthen their segregation. The present study reveals additional differences in the form of their epidermal cells, stomatal development and orientation. However, the near perigenous development of stomata in *Trapa* could even be correlated with reduction following the adoption of an obligate aquatic habit. The stomata of many confirmed aquatics, e.g., *Nymphoides peltatum* (my unpublished observations) and Lemnaceæ[8] also have fewer divisions in and around their meristemoids than some related Gentianaceæ and Araceæ. Possibly the same type of hydrophytic reduction could also account for the closed vascular bundles of *Trapa*, the epistomatic character of whose leaves is attributable to their floating habit. The marked unidirectional orientation of the stomata of *Trapa* the occurrence of thick and thin-walled epidermal cells with slightly sinuous sides in its leaves (uniformly thin walls of epidermal cells in other investigated plants are deeply sinuous), the presence of raphides in all Onagraceæ except *Trapa* and of septate multicelled simple hairs exclusively in the latter are seemingly significant. However, I found druses in leaves of *Trapa* as well as *Jussieua repens*. The genus *Trapa* thus presents many aberrant characters which at once distinguish it from other Onagraceæ. At the same time the features and tendencies which Onagraceæ have in common with *Trapa* suggest that it is best placed adjacent to that family.

I am grateful to Dr. Bharati Mehra for help and to Dr. D. D. Pant for guidance.

Department of Botany,   PARVEEN KIDWAI.
The University,
Allahabad, *October 27, 1964.*

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A NEW TYPE FOUND IN CORN

STURTEVANT[1] divided *Zea mays* into several groups and considered each to be a specific rank, several of the major character differences being dependent upon a single factor pair. The classes are: (*i*) pod corn, (*ii*) flint corn, (*iii*) pop corn, (*iv*) dent corn, (Jones[2]), (*v*) sweet corn (East[3]), (*vi*) flour corn and (*vii*) waxy corn. Hayes, Immer and Smith[4] have stated that the starchy types behave as a simple dominant to sugary or waxy types.

Manglesdorf[5] and Cameron[6] reported the occurrence of a new type, *viz.*, amplaceous sugary. According to them, another gene pair, *viz.*, Du/du is involved along with an allel of Su gene which controls starchy character, the allel being su^{am}. The amylaceous sugary type reported by them is less translucent, is of a dirty appearance and is less wrinkled than sugary in the lower half of the seed.

Vaidya and Bhag Singh[7] working with sweet corn reported the occurrence of still another type which they called 'semi-sweet'. In this type, the grains have a considerable amount of soft starch in the upper half of the grain as compared to amylaceous sugary reported by Manglesdorf.[5] This semi-sweet was later crossed

to a dent line in 1962 *Zaith* and the resultant (dent × semi-sweet) cross was backcrossed to semi-sweet in 1962 *kharif* season. Segregates of dent and semi-sweet in about 1 : 1 proportion were obtained. The semi-sweet so obtained was grown at Hyderabad in *rabi* 1963. On being sibbed, it gave rise as observed for the first time to sweet kernels with clear dent and soft starch in the upper half of the grain as in semi-sweet. The occurrence of these two different characters, *viz.*, sweet and dent, so far reported to be recessive and dominant to each other, side by side, in the same grain gives rise to interesting speculations about the gene control in the development of endosperm in maize.

The endosperm of maize can be easily divided into two parts, *viz.*, (*i*) surrounding core which is either corneous, starchy or translucent and (*ii*) central portion which is always starchy (soft) to a more or less extent. According to this division, pop corn has a rather small soft starch central portion surrounded on all sides by a corneous surrounding core, flint corn has a well-developed central soft starch portion with a corneous surrounding core all round, in dent corn a well-developed central soft starch portion extends right up to the top of the grain and the surrounding corneous core is present on the sides only, flour corn has both these central portion as well as the surrounding core consisting of soft starch while sweet corn has a very rudimentary central soft starch portion with a surrounding core of translucent type. In all these types, the central soft starch is located immediately above the embryo. While in the new type reported here the central soft starch is separated from the embryo by a translucent layer and has a characteristic shape (see Fig. 1).

This new find offers itself as a good experimental material for the study of gene action involved in the development of endosperm in maize. Hayes, Immer and Smith[4] proposed a single major gene theory. However, Manglesdorf[5] has reported the occurrence of amylaceous sugary due to the interaction of two genes, *viz.*, su^{am} and du. The study made so far of this new find indicates that the development of endosperm in maize does not involve the interaction of genes but the two genes act independently on the same character, *viz.*, the endosperm, to produce the type concerned.

As regards the commercial possibilities it was observed that this new find develops two good cobs per plant and can transmit this character to hybrid progeny. When crossed to sweet corn, the new find yielded a hybrid which, in field test, was found superior to K.T. 41, a promising
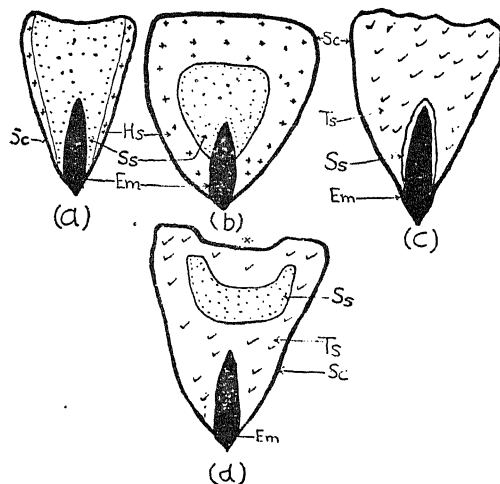
FIG. 1. (*a*) Dent (*b*) Flint, (*c*) Sweet, (*d*) New find. *Sc*, Seed-coat; *Em*, Embryo; *Ss*, Soft starch; *Hs*, Hard starch; *Ts*, Translucent sweet part. In (*d*) note dentation in grain at *.

open pollinated Indian variety, and practically equal to Deccan hybrid and Ganga 101. Experiment with this new find are in progress to study the gene action involved in the development of endosperm in maize and to fully explore the commercial possibilities of sweet dent × sweet hybrids.

Division of Botany,   S. M. Vaidya.
Indian Agricultural
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REVIEWS AND NOTICES OF BOOKS

Developments in Applied Spectroscopy (Vol. 3). Edited by J. E. Forrett and Elma Lanterman. (Plenum Press, 227 W, 17 St., New York, N.Y. 10011), 1964. Pp. 409. Price $ 17.50.

The volume under review is comprised of thirty-two papers contributed to the Fourteenth Annual Mid-America Spectroscopic Symposium held at Chicago from 20th May to 23rd May, 1963. They are grouped under six headings, *viz.*, 1. X-ray Spectroscopy; 2. Infra-red Raman Spectroscopy; 3. Emission Spectrography; 4. Nuclear Magnetic Resonance and Electron Spin Resonance; 5. Ultra-violet Spectroscopy; and 6. Gas Chromatography.

Amongst important topics dealt with may be mentioned the expanded use of X-ray fluorescence equipment in process stream analysis and control, recent advances in sample-handling devices for liquids, slurries and solids, the laser microprobe, and a simple and effective attenuated total reflection unit for the ultra-violet-visible-near infra-red region designed for use in a standard spectrophotometer.

C. V. R.

Recent Progress in Surface Science (Vol. 2). Edited by J. F. Danielli, K. G. A. Pankhurst and A. C. Riddiford. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xiii + 541. Price $ 18.00.

Surface studies cover a very wide field. There is therefore a real need by bringing together critical reviews of advances made by workers in different disciplines into one series of volumes. The present volume contains a series of ten articles whose subjects and authors are as follows: 1. Physical Adsorption at the Gas-Solid Interface, by M. M. Dubinin, B. P. Bering and V. V. Serpinskii; 2. Heterogeneous Catalysis, by D. Brennan; 3. Contact Angles, by G. E. P. Elliott and A. C. Riddigord; 4. Emulsions, by J. T. Davies; 5. Flotation, A. S. Joy and A. J. Robinson; 6. The Genetic Control of Cell Surfaces, by G. H. Beale; 7. The Physiology of Pinocytosis, by Ronald C. Rustad; 8. Plastron Respiration, by D. J. Crisp; 9. Preparation and Properties of Isolated Cell Surface Membranes, by C. H. O'Neill; and 10. The Cell Membrane: Image and Interpretation, by P. F. Elbers.

C. V. R.

Fluorine Chemistry (Vol 3). Edited by J. H. Simons. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xi + 240. Price $ 10.00.

The present volume of this series is devoted entirely to the biological effects of fluorine compounds. This is a subject of great importance owing to the rapidly increasing use of fluorine-containing compounds of carbon for a great variety of practical applications. The material of the volume has been dealt with under five heads, *viz.*, Fluoroacetate, Phosphofluoridates, Acute Effects of Organofluorine Compounds in Experimental Animals, Effects of Acute Doses of Fluorine-Containing Organic Compounds and finally, Chronic Experimental Intoxication. The information collected on all compounds is presented in the form of tables for easier reference and comparison. An extensive bibliography is also given so that the reader can locate the original sources.

C. V. R.

Progress in Oceanography (Vol. 2). Edited by Mary Sears. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. 271. Price 80 *sh.* net.

Oceanography is a rapidly expanding field. The present series of volumes does not attempt to be an 'annual review' but rather presents topics of interest which provide an up-to-date assessment of some of the more recent work on problems of significance in oceanography. This second volume contains papers on: A Survey of Marine Bottom Samplers; The Major Deep-Sea Expeditions and Research Vessels 1873-1960—a Contribution to the History of Oceanography; The Vertical Distribution of Zooplankton in the Sea; The Distribution of Phosphorus and Oxygen in the Atlantic Ocean as observed during the I.G.Y. 1957-58.

C. V. R.

Primitive Motile Systems in Cell Biology. Edited by Robert D. Allen and Noburo Kamiya. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 642. Price $ 22.00.

In this volume are collected thirty papers presented at a Symposium held at Princeton University in April, 1963, together with the paper discussion. At the Symposium, nearly

a hundred scientists, representing a variety of different interests, gathered to consider the very elusive problem of how movement occurs at the cell level and below. Until recently, the phenomena were poorly understood. Within the past decade, however, research on motility has begun to bear fruit largely due to the introduction of improved methods.

The papers in the volume have been grouped into four parts, *viz.*, I. Cytoplasmic Streaming in Plants and Myxomycetes (Mycetozoa), II. Cytoplasmic Streaming and Locomotion in the Free-Living Amebæ, III. Cytoplasmic Streaming, Locomotion, and Behaviour of Specialized Ameboid Cells, and IV. Non-Brownian and Saltatory Motion of Subcellular Particles, and Mitotic Movements.

The work is beautifully produced and richly illustrated and in view of the basic importance of the subject, it will be enthusiastically welcomed. C. V. R.

Elements of Numerical Analysis. By James Singer. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 395. Price $ 8.75.

A text for undergraduate and graduate students in mathematics, this book provides a comprehensive introduction to computational errors ; accuracy and precision ; and polynomial approximation at a point and in an interval, including interpolation, extrapolation and sub-tabulation. It covers the numerical solution of algebraic and transcendental equations, encompassing both arithmetic and graphic-nomo-graphic methods, numerical differentiation and integration, solution of differential equations, and curve fitting. There are about 40 diagrams and twelve tables. C. V. R.

An Introduction to Numerical Mathematics. By Eduard L. Stiefel. (Academic Press, New York and London), 1963. Pp. 286. Price $ 6.75.

This book is specially designed for junior or senior students in mathematics, science, and engineering.

The author stresses the algorithmic point of view throughout, and clearly demonstrates how a small number of basic algorithms are the fundamental building blocks of many modern computational methods. Typical of this approach are the first three chapters on linear algebra, linear programming, and least-squares approximation, which are largely based on a single

algorithm (Jordan exchange). Other chapters present authoritative coverage of non-linear algebra, eigenvalue problems, ordinary and partial differential equations, and approximations. C. V. R.

Cytology and Cell Physiology. Third Edition. Edited by Geoffrey H. Bourne. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 780. Price $ 20.00.

The first edition of this book appeared in 1941 and the second in 1951. During the twelve years that have elapsed since the second edition has appeared, major developments have occurred in this field and the new edition provides comprehensive articles on the most recent developments. The subjects dealt with in this book and their respective authors are as follows : 1. Introduction, by Ross C. MacCardle ; 2. Centrifugal Isolation of Subcellular Components, by Walter C. Schneider and Edward L. Kuff ; 3. Microscopy, by R. Barer ; 4. Selected Physical and Physicochemical Methods, by Howard Jenerick ; 5. Enzyme Histochemistry and Cytochemistry, by M. S. Burstone ; 6. The Cell Surface and Cell Physiology, by Freda Brown and J. F. Danielli ; 7. The Endoplasmic Reticulum, by Fritiof S. Sjostrand ; 8. Mitochondria and the Golgi Complex, by Geoffrey H. Bourne and Hrishi Bhu Tewari ; 9. The Nucleus and Chromosomes : A Cytological Perspective, by Montrose J. Moses ; 10. Nucleo-cytoplasmic Relationships, by Lester Goldstein ; 11. Viruses and Cells, by F. Kingsley Sanders ; 12. Pathological Changes in Cells, by Roy Cameron and 13. The Cancer Cell, by Roy Cameron. C. V. R.

Organic Chemistry. By Hans Beyer. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1964. Pp. xv + 761. Price not given.

Prof. Hans Beyer's text-book of organic chemistry in German the *Lehrbuch der organischen Chemie* is well known. The popularity of the book is at once guaged by the fact that it went since its original publication through several quick editions, and is still in demand.

The present English text is a translation (by Dr. E. B. Knott) of the 10th Edition of the German book. It is a modern book on the subject and brings together, in a fundamental way, the well-known classical facts with the modern theoretical views on chemical electronic

theory and its extensive application in the field of organic chemistry. The student is introduced to the basic principles of electronic and orbital theories even in the first few chapters so that he starts with a modern outlook on the subject which is so essential to keep pace with recent developments and to understand current literature.

Classifications of the subject are on traditional lines, namely, aliphatics, alicyclics, aromatics, terpenes and steroids, and lastly proteins and enzymes.

The book can specially be recommended to honours and post-graduate students of organic chemistry in Indian Universities, as it will provide them with a clear understanding of modern organic chemistry and organic chemical reaction mechanisms. The English translation should receive a warm welcome in this country.

A. S. G.

Glass Ceramics. By P. W. McMillan. (Academic Press, Inc., London, Ltd., Berkeley Square, London W-1), 1964. Pp. viii + 229. Price 46 *sh.* 6 *d.*

Glasses are amorphous solids which are solidified from melts without crystallizing whereas glass-ceramics are polycrystalline solids prepared by controlled crystallization of glass melts of special composition. To promote the controlled crystallization it is necessary to have suitable nucleating agents capable of existing in the glass melts in the form a dispersion of colloidal dimensions. Titanium dioxide is a well-known nucleating agent for controlled crystallization of glasses; other materials which will act as catalysts for nucleation have been investigated.

Developments in the preparation of glass-ceramics are of recent origin, and there is scope for wide studies, both experimental and theoretical, in this field. An important feature of glass-ceramic process is that it is applicable to a wide range of compositions and this, together with variations in the controlled heat-treatment, means that types of glass-ceramics with different physical properties can be prepared. This has an important bearing on the practical applications of glass-ceramics, not only in technical and engineering fields but also in the production of consumer goods.

The book under review, perhaps the first comprehensive treatment on the subject, deals with all aspects of glass-ceramics—the theory underlying their nucleation and crystallization, their preparation, properties, applications and

future lines of development. The subject being comparatively new in the field of materials science and technology, the book will be welcomed by workers in this field of study.

A. S. G.

A Systematic Classification of Types of Intermetallic Structures. By P. I. Kripyakevich. (Published by Consultants Bureau, Plenum Press, 227 W, 17th Street, New York, N.Y. 10011), 1964. Pp. 35. Price $ 10.00.

This is a Reprint from the *Journal of Structural Chemistry*, Vol. 4 (1963), and is an authorized translation from the original Russian text.

During the fifty years since the beginning of X-ray structural analysis, nearly 400 intermetallic and related types of structure have been discovered which contain two or more components. Attempts have been made in the past to classify these types according to various criteria.

In the present review the author has proposed a classification of these types based on a single criterion which reflects the interaction of the atoms in the structures, namely, on the co-ordination of the atoms (co-ordination numbers, configurations of co-ordination polyhedrons, and their method of combination). Such a classification is applicable to all types of intermetallic structures. The review includes binary, ternary, and quaternary compounds having metallic properties. The literature cited includes nearly 300 references up to the end of 1961.

The Reprint will no doubt be of great benefit to all workers in this particular field of X-ray structural analysis.

A. S. G.

The Arlington Practical Botany Book I—*Plant Anatomy.* By Mary-Anne Burns. (Arlington Books, 15 Duke Street, St. James', London S.W. 1), 1965. Pp. 104. Price 15 *sh.*

The author during her initial experience as a teacher of botany felt the lack of reference books which can be used by students in their laboratory work in botany. She herself has enthusiastically come forward to fulfil this need by undertaking to bring out six practical guides in botany for use in schools and colleges.

The first of the series is on Plant Anatomy. It contains 230 carefully prepared drawings with explanatory notes which will be of help to the students in the identification and clear understanding of the cellular structure of the various plant organs. The drawings are so good

that the students may even be tempted to copy them. They are however intended for guidance only and should be followed in the practical study according to the advice for students given by the author in the first two pages of the book.

The book is beautifully produced and if the succeeding volumes keep up the present standard, there is no doubt that the set will become an indispensable acquisition to teachers and students of botany.   A. S. G.

Features of Afro-Alpine Plant Ecology. By Olov Hedberg (Acta Phytogeographica Succica 49) (Almqvist Wiksells Poktryckeri AB., Uppsala), 1964. Pp. 144.

The author Olov Hedberg is well known for his earlier contributions on the taxonomy and ecology of the Afro-Alpine vegetation. Inhabiting an extreme environment, the Afro-alpine region is poor in species and the author earlier recognised 230 taxa as regular members of the Afro-alpine flora in tropical East Africa. A fuller phytogeographical account of this flora was deemed impracticable on account of the absence of detailed data of the life-forms of some of these plants and their adaptation to Afro-alpine climate. The present work under review claims to provide such data.

The book contains chapters on Afro-alpine environment, adaptive trends in the Afro-alpine flora, Afro-alpine life-forms, water-economy in the Afro-alpine flora and principal Afro-alpine plant communities.

The author describes primarily the macro- and micro-climate, soils, solifluction, fire and biotic influences. The wind conditions, snow and glaciers are of special interest. It is quite interesting to note the adaptive trends, *e.g.*, xeromorphy, reduction of the length of internodes, etc., as an adaptation against the radiations, temperature insulation, frost heaving resistance, etc. Besides these, the life-forms such as grasses, sedges, acaulescent rossette plants, cushion plants, etc., are present along with a number of geophytes, particularly of the families Cyperaceæ, Juncaceæ, Liliaceæ and Iridaceæ; Hemicryptophytes, a few Chemæphytes and Therophytes. Though our knowledge about the alpine regions of the Himalayas is very inadequate, Olov Hedoerg's work provides us valuable information for comparative studies.

One thing that requires special mention is the concept of alpine vegetation by different authors. For comparison with other tropical mountains, the alpine zone has been defined as the zone without ligneous elements and the zone below it with dwarf shrubs as the 'sub-alpine'. Under such definition the giant forms of Lobelias and Senecios, typical of this region, hardly come under the term alpine forms.

The book which deserves to be widely read and used is useful to students and researchers of tropical mountain plants ecology.

RAJ KUMAR GUPTA.

Books Received

Applied Mathematics and Mechanics (Vol. 8)— *Perturbation Methods in Fluid Mechanics.* By Milton Van Dyke. (Academic Press, New York), 1964. Pp. x + 230. Price $ 7.00.

Photoelectric Effects in Semiconductors. By S. M. Ryvkin (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. xv + 402. Price $ 22.50.

Ultrasound Physical, Chemical and Biological Effects. By I. E. El'piner. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. viii + 371. Price $ 22.50.

Ultrasonic Cutting. By L. D. Rozenberg, V. F. Kazantsey, L. O. Makarov and D. F. Yakhimovich. (Translated from Russian by Lewis Balamoth). (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. xi + 142. Price $ 17.50.

Strength and Deformation in Non-Uniform Temperature Fields. Edited by Prof. Ya E. Fridman. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 169. Price $ 25.00.

Soviet Researches on Luminescence. Edited by D. V. Skobel'tsyn. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 152. Price $ 27.00.

Intensity Theory for Infra-red Spectra of Polytomic Molecules. By L. A. Gribov. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 113. Price $ 15.00.

Structure Formation in Alloys. By Il'ya Vasil'evich Salli. (Consultant Bureau Enterprises, Inc., New York), 1964. Pp. 140. Price $ 18.50.

International Conference on Cosmic Rays Proceedings (Vol. 3)—*Composition, Origin and Pre-history.* (Secretary, I.C.C.R., Tata Institute of Fundamental Research, Colaba, Bombay-5), 1964. Pp. 510. Price Rs. 24·00.

Guide to Gas Chromatography Literature. By A. V. Signeur. (Plenum Press, New York), 1964. Pp. 351. Price $ 12.50.

SCIENCE NOTES AND NEWS

Award of Research Degrees

The Utkal University has awarded the Ph.D. degree in Agricultural Botany to Shri B. Misro, Central Rice Research Institute, Cuttack, for his thesis entitled "Studies in the Inheritance of Anthocyanin Pigmentation in Rice".

The Osmania University has awarded the Ph.D. degree in Physics to Shri E. Venkateswara Rao for his thesis entitled "The Vibration Spectra of Organic Molecules and Their Normal Co-ordinate Treatment".

International Conference on Luminescence

An International Conference on Luminescence, sponsored by the I.U.P.A.P. and organised by the Hungarian Academy of Sciences, will be held from August 23 to 30, 1966, in Budapest.

The program will include sessions on: General Theory of Luminescence; Inorganic Crystalphosphors; Organic and Amorphous Luminophors, Application of Luminescence. Further information available from Dr. G. Szigeti, Director of the Research Institute for Technical Physics of the Hungarian Academy of Sciences, Budapest, POB: Ujpest 1, No. 76, Hungary.

Indian Council of Medical Research : Award of Fellowships

The Indian Council of Medical Research invites applications (before 15th June 1965) from Medical graduates, with experience in research, for the award of Fellowships of the National Institutes of Health, U.S.A., for training in that country. Application forms and further details can be had from The Director, Indian Council of Medical Research, Post Box 494, New Delhi.

Rapid Dyeing of Wool

A method of dyeing wool developed in the Division of Textile Industry of the CSIRO, Australia, promises to be much quicker than conventional methods. The investigations (Report No. G 12) of McPhee and Hine have shown that wool can be processed at 90° C. for up to 30 minutes without significant damage if acidity is controlled within the narrow range pH $3 \cdot 6$–$4 \cdot 2$. Further experiments have shown that dyeing is possible in this optimum pH range and at safe temperatures if a suitable detergent is used as dyeing assistant. The detergents evolved are polyoxy-ethylated monylphenols having 6 to 10 moles of ethylene oxide to each mole of monylphenol.

The procedure differs in details for different kinds of dyes, but in all cases total times of only about half the time for conventional dyeing are required.—(*Australian Science Newsletter.*)

On the Occurrence of *Isoetes panchananii* Pant and Srivastava in Andhra Pradesh

A. N. Henry, Botanical Survey of India, 76, Lower Circular Road, Calcutta-14, writes:

Isoetes panchananii was recently described by Pant and Srivastava from Ram Nai, Rewa, Madhya Pradesh (*Proc. Ind. Acad. Sci.*, 1962, 28 B, 243). But for the type locality, this species is only known doubtfully from Panchgani, Maharashtra. The author, while undertaking botanical exploration work in Andhra Pradesh, collected this species at Pakhal Lake, Warangal District, on February 25, 1963; plants were seen growing luxuriantly in association with *Isoetes coromandilina* L., *Fuirena ciliaris* (L.) Roxb., *Scirpus supinus* var. *lateriflorus* (Gmelin) Koyama and *Glossostigma spathulatum* Arn., along the margin of Pakhal Lake. The occurrence of this plant in Andhra Pradesh constitutes a noteworthy distribution to South India.

Isoetes panchananii can be easily distinguished from *I. coromandilina* by adult plants being smaller and megaspores clearly reticulate.

Specimen examined : *Henry 15982*, deposited in the Southern Circle Herbarium, B.S.I., Coimbatore (MH).

New Information Services for Scientists

The volume of publication in the scientific literature has become so extensive in recent years that the individual scientist or executive can no longer keep up with this himself. To keep abreast with research publication, the largest laboratories employ graduate-staffed information departments : for those who cannot afford this, however, a new British project operated by the Scientific Documentation Centre is supplying "Current Awareness Services". These give complete information services for laboratories without information departments ; and services on specialized topics to extend the coverage of existing information units.

The coverage of the Service is based on systematic graduate scanning of over 1,200 of the world's leading scientific, technical and medical journals, and includes all the U.S. Government Research Report material, British and U.S. University thesis titles and scientific book titles, including many from Russia.

The material is forwarded weekly on subject-classified cards. Cards of interest can be copied and forwarded to the persons concerned. Copies of originals and abstracts can be obtained through the Centre.

About 100 subjects from science, technology and medicine are available in the Current Awareness Service. The Centre also has over 100,000 spectra or sets of spectral data which are made available on a service basis.

Further details of the Current Awareness and Spectra Services can be obtained from Dr. P. S. Davison, Director, Scientific Documentation Centre, Halbeath House, Dunfermline, Fife, United Kingdom.

New Technique in the Electron Microscope Study of Viruses

Photographs taken with the electron microscope (electron micrographs) of objects, which are only just big enough to be seen at all, tend to be very difficult to interpret. The reason is that towards the limit of resolution what is technically known as "noise" becomes as important as true details of the picture, while at the same time more and more details are missed.

The Agricultural Research Council's Virus Research Unit, at Cambridge, has evolved a new technique of making its electron micrographs of viruses, taken near the limit of resolution much clearer than used to be possible.

All viruses are composed of a number of identical sub-units, representing sections of the protein overcoat which protects the inner nucleic acid which is the real working part of the virus. The number of identical sub-units varies from many thousands to as few as ten or twenty, according to the complexity of the virus. The sub-units may be arranged in a spiral, a string, or a symmetrical circular pattern.

In the new technique, separate photographs are taken of a large number of different sub-units. These photographs, fifty or more of them, are then very precisely superimposed. The features which the photographs have in common, that is, the real repeated structure of the sub-units are thus amplified fifty or more times over and so stand out very clearly. There is only a very small chance that any significant details will still be missing. Meanwhile the noise, being different for each photograph, is not amplified and so become relatively fainter at each successive superimposition.

This new technique of superimposition of electron micrographs is semi-automatic, and it can be applied to other microstructures as well.--(*British Information Service.*)

Alpha Radioactivity in Less Heavy Elements

Alpha radioactivity or alpha decay is generally associated with the heavier elements. Hence the report of an observation of alpha decay from nuclides in the region of mass 100 is of some interest.

It has long been recognized from atomic mass data that there is present an enhancement of the alpha-decay energies of the tellurium isotopes due to what is known as the effect of the 50-proton closed shell. The enhancement, however, is not large enough to produce a detectable instability towards alpha particle emission among the tellurium isotopes presently known

R. D. Macfarlane and A. Siivola report observations on the alpha radioactivity of the very light tellurium isotopes hitherto unknown, whose alpha-decay energies are additionally enhanced by the $N = 50$ closed shell.

In the experiment a 90% enriched Ru^{96} target was bombarded with high energy O^{16} ions from the Berkeley heavy-ion linear accelerator. The alpha-particle energy spectrum of the products of the reaction, studied by known techniques, showed two alpha emissions, at energies $E\alpha = 3 \cdot 28$ MeV and $3 \cdot 08$ MeV, which decayed with half-lives of $2 \cdot 2$ sec. and $5 \cdot 3$ sec. respectively.

The observed results have been interpreted as due to the formation of new isotopes Te^{107} and Te^{108} of tellurium in the $Ru^{96} + O^{16}$ reaction, and their decay by alpha emission enhanced by the closed shell configuration of protons. The reactions leading to alpha emissions are: Ru^{96} $(O^{16}, 5\,n)$ Te^{107} $3 \cdot 28$ MeV and R^{96} $(O^{16}, 4\,n)$ Te^{108} $3 \cdot 08$ MeV.—(*Phys. Rev. Letters,* 25 January 1965.)

THE NEW PHYSIOLOGY OF VISION

Chapter XVI. Further Studies of the Retinal Responses

Sir C. V. RAMAN

IN the present chapter will be set out the results of the study of the functioning of the retina by the method which makes use of special colour-filters as has been fully explained in the preceding chapter. Observations with thirty filters made with seven different dye-stuffs have already been described in that chapter. The results which emerged are sufficient by themselves to lead to definite conclusions. However, many more filters had been fabricated with several other dye-stuffs and it was considered desirable to complete the study making use of such of them as are suitable for the observations. The results obtained and set forth here confirm and in certain respects usefully supplement the earlier findings. The significance of these findings in relation to the structure and functioning of the retina will be discussed in the next chapter.

Filters of Cotton Blue.—This dye-stuff incorporates itself smoothly into gelatine films, making admirably clear filters exhibiting a blue colour of which the depth is determined by the quantity of the dye taken up. Spectroscopic examination shows that the absorption by the dye is strongest in the yellow region of the spectrum, *viz.*, at 580 mμ. The filters are completely transparent to the shorter wavelengths in the spectrum up to about 550 mμ. Beyond the yellow again, there is a sensible absorption which results in the orange and red of the spectrum being much weakened.

When such a filter is held before the eye of the observer who views a brightly-illuminated white screen for a little while and the filter is then removed with the vision fixed at a particular point on the screen, a picture of the observer's retina flashes into view. The most conspicuous feature in the picture is a bright yellow disk which is an enlarged image of the fovea with a bright yellow spot at its centre and a distinctly brighter rim around its margin. Encircling the foveal disk appears an area of circular shape with a fairly well-defined outer margin. This has a diameter some four times greater than that of the foveal disk. The colour of this region is yellow with a slight greenish-tinge. The rest of the screen displays a glow of which the yellow hue is readily distinguish-

able from the colours noticed in the regions which it surrounds.

Filters of Coomassie Brilliant Blue.—This dye-stuff when incorporated into gelatin films makes very satisfactory filters. Their colour as seen by transmitted light alters progressively from a light to a deep blue as the quantity of the dye taken up is increased. The filters prepared were transparent to the whole visible spectrum except in the region between 550 mμ and 630 mμ. This region which includes the greenish-yellow, yellow and orange sectors is totally absorbed by the more heavily-dyed filters. In the observations made in the usual manner with such filters, the most conspicuous feature is the foveal disk with a bright spot at its centre and a bright rim around its margin. It exhibits a greenish-yellow colour. The foveal disk appears encircled by a circular region which is less luminous but much larger in area. This again appears surrounded by a field exhibiting an orange-yellow hue. From the observed features, it is evident that the foveal disk and the luminous area immediately surrounding it owe their origin to the absorption by the filter appearing between 550 mμ and 590 mμ, while the orange-yellow glow appearing in the outer parts of the field arises from the spectral region between 590 mμ and 630 mμ.

Filters of Bromophenol Blue.—Three filters dyed to different depths were obtained with this material, the colour exhibited by them in transmitted light showing the progression from a lighter to a deeper blue to be expected in the circumstances. Spectroscopic examination of the transmitted light showed with all the three filters, a band of complete extinction in the wavelength range between 590 mμ and 630 mμ covering the orange sector of the spectrum. In addition, an absorption was also exhibited in the wavelength range between 560 mμ and 590 mμ covering the greenish-yellow and yellow parts of the spectrum. This absorption was relatively weak in the first of the three filters, much stronger in the second filter and practically complete in the third filter.

The effects exhibited to the observer's vision with the three filters showed very clearly a progressive change. The foveal disk and the

luminous area immediately surrounding it were only dimly seen with the first filter, were much stronger with the second and very conspicuous with the third. The colour exhibited by the foveal disk was a pale greenish-yellow and that of the area immediately surrounding it which was less luminous appeared to be the same. On the other hand, the outer parts of the field exhibited an orange-yellow hue.

Filters of Coomassie Violet.—Excellent colour filters are produced by incorporating this dye-stuff into gelatine films. The colour of the light transmitted by the filters may be described as rose-red. Spectroscopic examination shows the filters to be completely transparent to all parts of the spectrum except the green in which there is an absorption band covering the wavelength range between 520 mμ and 570 mμ, the strongest absorption being at 545 mμ. It is necessary to hold the filter in front of the eye for at least a couple of minutes on the first occasion before removing it in order to perceive the effect which results from its removal, *viz.*, a greenish-yellow glow covering the entire screen except the foveal area at the centre of the field. This latter area appears quite dim, the glow seen elsewhere being totally absent in it. The phenomenon can be seen again and again, merely by putting back the filter before the eye and then removing it.

Filters of Phloxine.—Two filters had been prepared with this dye, one of them being more strongly dyed than the other. Spectroscopic examination shows the absorption by the phloxine filters to be exclusively in the green of the spectrum, there being complete transparency in other parts. The more deeply-dyed filter shows a complete cut-off of the spectral region from 535 mμ to 570 mμ coupled with a strong absorption from 500 mμ to 535 mμ. The less heavily-dyed filter shows a strong absorption in the wavelength range from 540 mμ to 565 mμ. Both filters give effects generally similar to those observed with the coomassie-violet filters and briefly described above.

Colour Filters of Fast Green.—A set of five filters prepared with this dye-stuff exhibit the characters best suited for such studies, *viz.*, perfect transparency over an extended region of the spectrum and a complete extinction in other regions. The filters show a regular progression of the colour as seen by transmitted light, *viz.*, from a bright blue for the most heavily dyed to a greenish-blue for the most lightly dyed. Spectroscopic examination shows a complete cut-off of all wavelengths greater than 560 mμ by the first filter. With the second filter, the cut-off has shifted to 580 mμ and with the third to 590 mμ. The fourth filter shows nearly perfect transparency up to 590 mμ while the orange and red regions have begun to appear in the transmitted light, a strong absorption showing itself in the red between 620 mμ and 670 mμ. With the fifth and last filter, only this absorption can be seen, the rest of the spectrum being transmitted freely.

The yellow foveal disk with a bright spot at its centre and a bright rim is the most conspicuous effect observed with the first filter. It is less conspicuous with the second filter and only with difficulty observable with the third and fourth filters. It is not visible with the fifth filter. A similar sequence of changes is observed in respect of the circular area which surrounds the foveal disk. On the other hand, the glow seen over the rest of the screen following the removal of the filter is a conspicuous feature in all cases. There is a clearly noticeable change in the colour of this glow, an orange-yellow with the first filter, an orange with the second and third filters, an orange-red with the fourth and just red with the fifth and last filter.

Colour Filters of Brilliant Green.—The four filters exhibiting a green colour by transmitted light prepared with this dye-stuff showed effects of a distinctive character, arising from the circumstance that they exhibit absorption at both ends of the spectrum. The absorption in the region of the shorter wavelengths extends up to 450 mμ and is conspicuous with the heavily-dyed filters, but is also noticeable with those more lightly dyed. In the region of long wavelengths, the yellow, orange and red sectors are completely absorbed by the heavily-dyed filter. The filters which are more lightly dyed exhibit little or no sensible absorption in the yellow. Their absorption is principally in the orange and the red where a dark band manifests itself in the wavelength range from 620 mμ to 670 mμ.

The yellow foveal disk with its usual accompaniments is quite conspicuous in observations made with the most heavily-dyed filter of the set. It is much less so with the second filter and scarcely observable with the third and fourth filters. Very striking also is the rose-red glow which appears covering the whole field following the removal of the filter in all cases. This phenomenon is clearly the result of the superposition of the glows produced by the parts of the spectrum at both its ends which

are absorbed by the filter and which impinge on the retina when it is removed.

Colour Filters of Tropœolin.—Three filters were prepared with this dye-stuff which by transmitted light exhibited respectively a golden yellow colour, a deep yellow and an orange-yellow hue respectively. The first of the three filters showed a cut-off of the shorter wavelengths in the spectrum up to 450 mμ and a noticeable absorption up to 500 mμ. With the second filter, the cut-off has shifted to 490 mμ with a perceptible absorption up to 510 mμ. The third filter exhibits a cut-off at 500 mμ and an appreciable absorption up to 520 mμ.

Observations with these three filters showed the effects already noticed with the auramine-yellow filters and described in the preceding chapter. Following the removal of the filter from before the eye of the observer, he notices a coloured glow over the screen, this however being definitely absent at the centre of the field in a circular area corresponding to the projection of the fovea of his retina on the screen. The colour of the glow is violet for the first, blue for the second filter and bluish-white for the third, the brilliancy of the glow increasing in that order. A dark spot at the centre of the foveal disk is very clearly seen. There are also indications of a radial structure in the foveal area.

Colour Filters of Acridene Orange.—Four filters were prepared with this dye-stuff. By transmitted light they exhibit a light orange hue in the case of the first filter, and progressively deeper orange hues for the others in the series. Spectroscopic examination showed that the first filter extinguishes all the shorter wavelengths in the visible spectrum up to 525 mμ. The wavelength of cut-off shifts to 535 mμ for the second filter, to 545 mμ for the third filter and to 550 mμ for the fourth.

The effects observed with the first of the acridene orange filters are very similar to those exhibited by the third of the series of tropæolin filters. In particular, the darker region at the centre of the field corresponding to the fovea was quite clearly seen. With the more heavily dyed filters of the series, this central region is less well-defined and less clearly observable. The appearance of the screen following the removal of the filter does not indeed differ very much from its appearance in the absence of the filter. A short-lived bright glow with a hint of blue in it is all that is actually observed.

THE SOLAR RED SHIFT

ONE of the predictions (the third prediction) of the General Theory of Relativity is the solar red shift, *i.e.*, spectral lines emitted by an atom in the sun, because of the higher gravitational potential of the sun, would be shifted to longer wavelengths as compared to corresponding terrestrial lines observed in the laboratory (*cf.* Recent attempts to test this prediction by Mossbauer effect). That there is such a solar red shift has been readily observed, but accurate measurements have proved the existence of a definite variation in the numerical value of the shift across the disk of the sun. The shift, instead of being constant as Einstein's prediction would require, is less than half the predicted value at the centre of the disk, and increases nearly to the predicted value near the limb. No satisfactory explanation could be given to this observational curve of variation of red shift across the solar disk.

In a paper to the *Canadian Journal of Physics* (1965, 43, 57) A. H. Gillieson explains the observed solar red shift curve of variation as the resultant of *two* gravitational effects: first the Einstein effect on the atom emitting the photon, and second, an effect on the emitted photon during its travel from the sun to the earth. To calculate the gravitational effect on the emitted photon, Gillieson postulates a dumbbell-shaped quantum mechanical model of the photon, having two "effective masses" each $m/2$ at the ends of an "effective diameter" $2r$, and rotating with a frequency v, and moving in the direction of the axis of rotation with a velocity c. Calculations have shown that the resultant of the two effects produces a curve similar to the observed one.

A theoretical consequence of the gravitational photon effect is that in addition to the bending of a light ray in passing close to the limb of the sun (the second prediction of Einstein), there should also be a slight reddening.

Based on this photon model the extra-galactic red shifts are interpreted as caused not by the Doppler effect caused by the recession of the galaxies (postulating an expanding universe) but by interaction and consequent loss of energy of the photon in passing through the inhomogeneities of the gravitational field in space.

From consideration of the ultimate fate of energy-degraded photons, the continuous creation of matter from such degraded radiation is suggested.—(*Canad. Jour. Phys.*, 1965, 43, 57.)

SEASONAL VARIATIONS IN THE ZONAL AND MERIDIONAL CIRCULATION OVER INDIA

R. ANANTHAKRISHNAN, A. R. RAMAKRISHNAN, M. MARY SELVAM AND
P. J. RAJAGOPALACHARI

(India Meteorological Department, Poona)

1. GENERAL CIRCULATION

THE large-scale wind systems of the atmosphere have their origin in the non-uniform distribution of heat and cold sources in the atmosphere. Over the tropics and sub-tropics the earth-atmosphere system receives more radiation than it sends out to space while at higher latitudes the conditions are just the opposite. Again, over the tropics the atmosphere receives heat in the lower levels by contact with the ground as well as by the latent heat released from the condensation of water vapour while there is a continual loss of heat by radiation from the top of the atmosphere. This non-uniform distribution of heat and cold sources in the atmosphere gives rise to horizontal gradients of temperature and pressure that drive the atmospheric heat engine converting potential and thermal energy into kinetic energy of air motion.

1.2. The seasonal oscillation of the sun between the Tropics of Cancer and Capricorn produces a corresponding oscillation in the disposition of the heat and cold sources and consequently of the wind systems of the atmosphere. The problem of the general circulation is concerned with the description and explanation of the large-scale wind systems.

2. EFFECT OF LAND-SEA CONTRASTS

2.1. The non-uniform distribution of land and sea over the globe influences profoundly the pattern of wind circulation. The ratio of land to sea area for the earth as a whole is 29 : 71. For the northern hemisphere this ratio is 39 : 61 while for the southern hemisphere the ratio is 19 : 81. Considering the eastern and western halves of the northern hemisphere, the areas covered by land and water are nearly equal for the eastern half while three-quarters of the western half are covered by sea. The extensive land masses of Eurasia and north Africa in the eastern half of the northern hemisphere constitute a major heat source in the summer months and a cold source in the winter months. These heat and cold sources are primarily responsible for the summer and winter monsoons of South Asia for which

there is no parallel elsewhere in the world. The Tibetan plateau which is the highest and most extensive plateau in the world also influences the general circulation over South Asia.

2.2. The influence of land-sea contrasts on the wind circulation is noticed up to high levels in the atmosphere. This is clearly brought out by Figs. 1 (a, b) and 2 (a, b) in which isopleths of the zonal winds over the latitude belt 0° to 60° N. are presented for the winter (December-January-February) and the summer (June-July-August) seasons at the standard isobaric levels of 500, 300, 200 and 100 mb. The strongest westerly winds in the winter occur at 200 mb. near latitudes 35° N. and longitude 140° E. (the southern parts of Japan); the strongest easterly winds in the summer months occur at 100 mb. level near latitude 15° N. and longitude 80° E. (the south Indian peninsula).

3. MEAN MONTHLY ZONAL AND MERIDIONAL CIRCULATION OVER INDIA

3.1. The seasonal variations in the zonal and meridional circulations over India have been studied using all the available rawin data at the 16 stations given in Table I for the period 1957-64.

TABLE I

Station	Latitude	Longitude	Period of data
1 Ahmedabad	23° 04′ N	72° 38′ E	1961–1964
2 Allahabad	25° 27	81° 44	1957–1964
3 Amritsar	31° 38	74° 52	1957–1960 (ul) (Jan)
4 Bombay	19° 04	72° 06	1957–1964
5 Calcutta	22° 39	88° 27	1957–1964
6 Gauhati	26° 05	91° 43	1957–1964
7 Jodhpur	26° 16	73° 03	1957–1964
8 Madras	13° 00	80° 11	1957–1964
9 Minicoy	08° 18	73° 00	1963–1964 (May)
10 Nagpur	21° 09	79° 07	1957–1964
11 New Delhi	28° 35	77° 12	1957–1964
12 Port Blair	11° 40	92° 43	1957–1964
13 Srinagar	34° 05	74° 50	1962–1964 (Aug)
14 Trivandrum	08° 30	76° 59	1957–1964
15 Veraval	20° 55	70° 22	1957–1964 (Jun) (Jun)
16 Visakhapatnam	17° 43	83° 14	1960–1964 (July)

The results are briefly discussed here for the four stations Trivandrum, Madras, Nagpur and New Delhi which lie approximately along the meridian of 77° E. and cover the latitude belt

ZONAL MEAN WIND COMPONENT

DEC-JAN-FEB   300 mb LEVEL

JUN-JUL-AUG   300 mb LEVEL

(b)

DEC-JAN-FEB   500 mb LEVEL

JUN-JUL-AUG   500 mb LEVEL
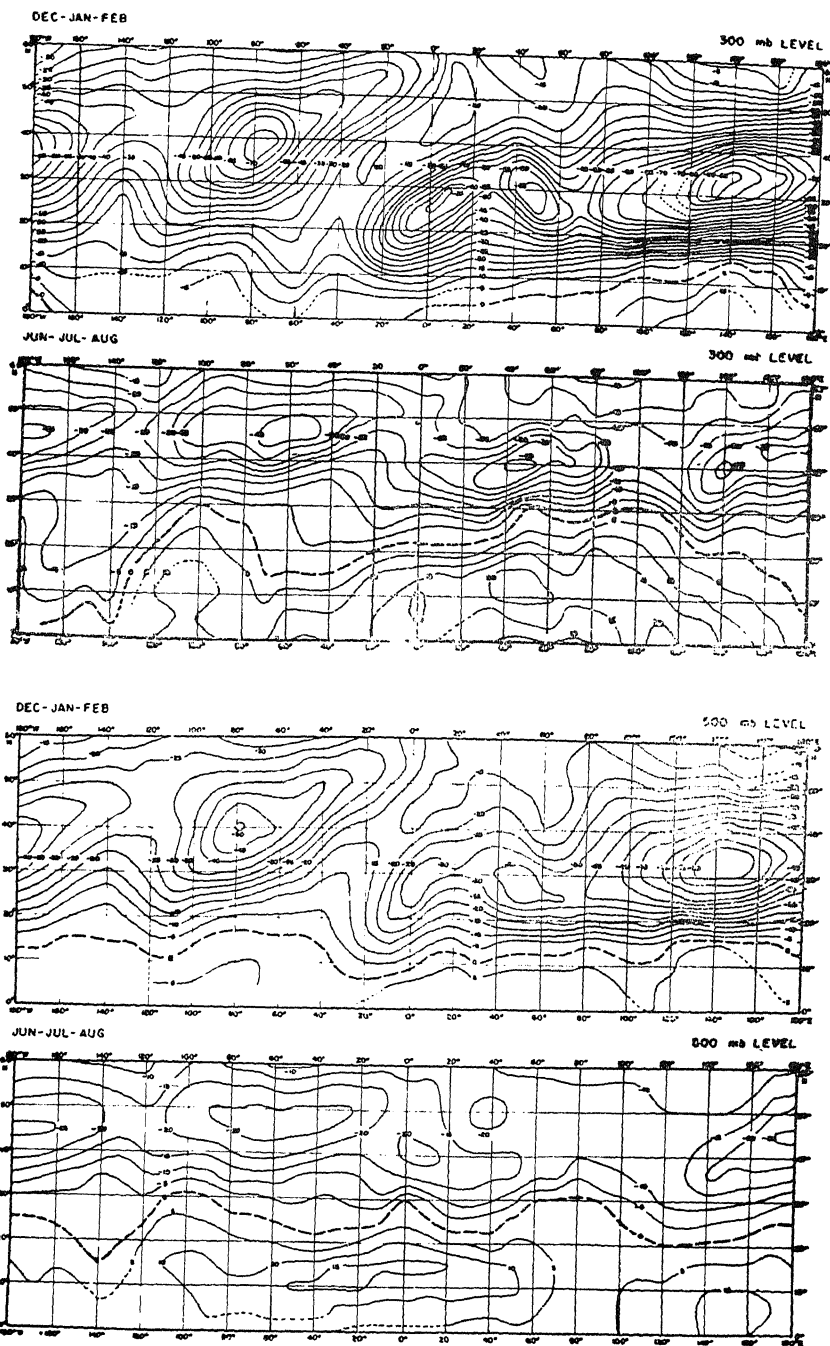
(a)

FIG. 1. (—) FROM WEST, SPEED IN KNOTS

from 8° 30′ N. to 28° 30′ N. Figures 3, 4, 5 and 6 depict isopleths of monthly mean zonal and meridional winds for these stations for the period 1957-1964. To bring out the salient

ZONAL MEAN WIND COMPONENT
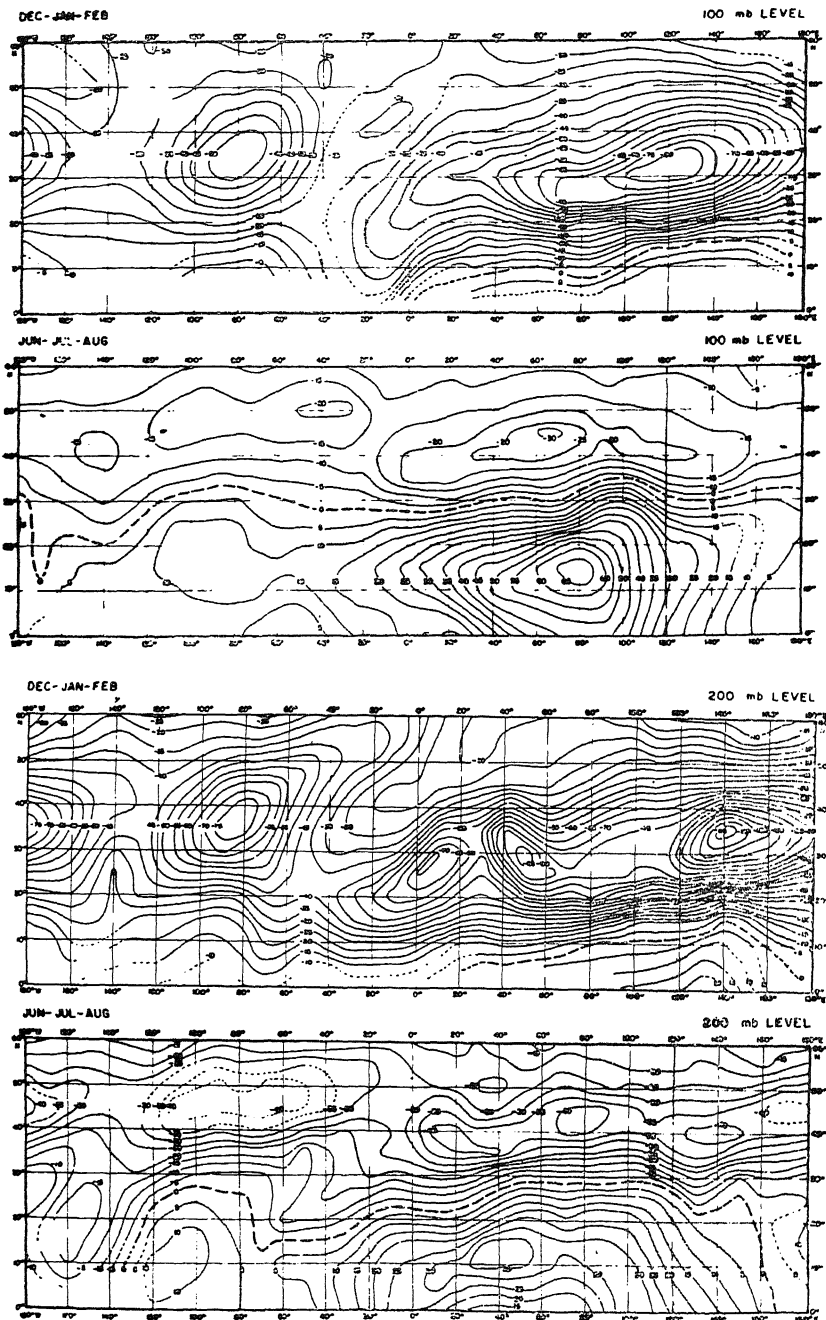
FIG. 2. (—) FROM WEST SPEED IN KNOTS

features, isopleths have been drawn at intervals of 20 knots of wind speed for both the zonal and meridional components.

3.1. Zonal Circulation

3.1.1. The major feature of the zonal circulation is the regularity of the variations associated

MONTHLY MEAN WINDS : TRIVANDRUM

M — MERIDIONAL   SPEED IN KNOTS   LAT. 08°28'N

Z — ZONAL   DOTTED AREA NORTH/EAST   LONG. 76°57'E

FIG. 3.

MONTHLY MEAN WINDS : MADRAS

M — MERIDIONAL   SPEED IN KNOTS   LAT. 13°00'N

Z — ZONAL   DOTTED AREA NORTH/EAST   LONG. 80°11'E
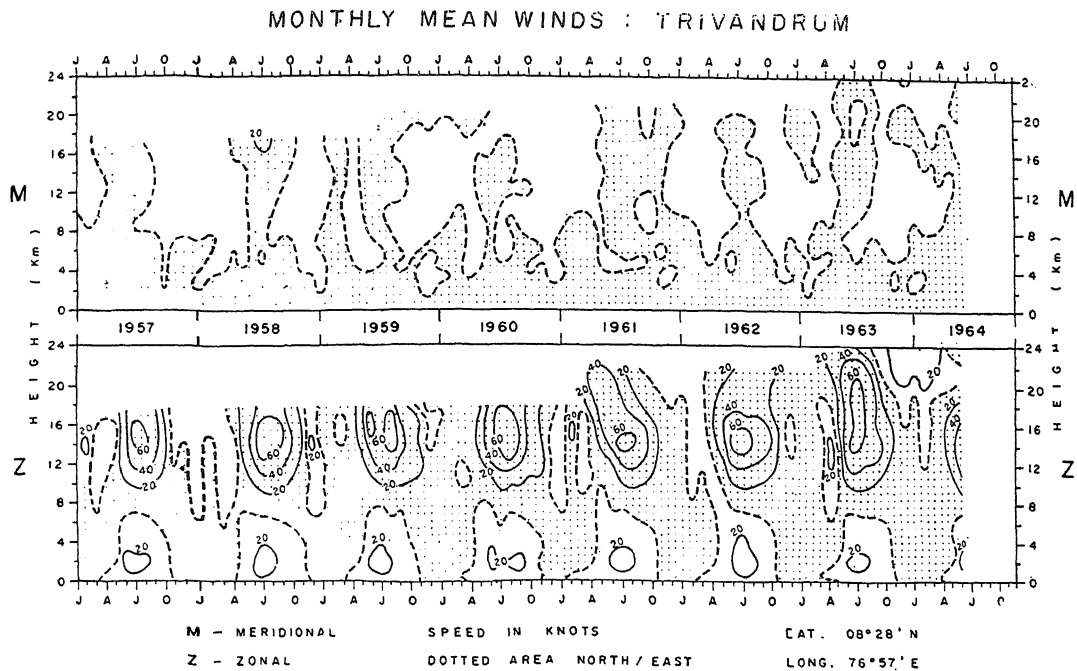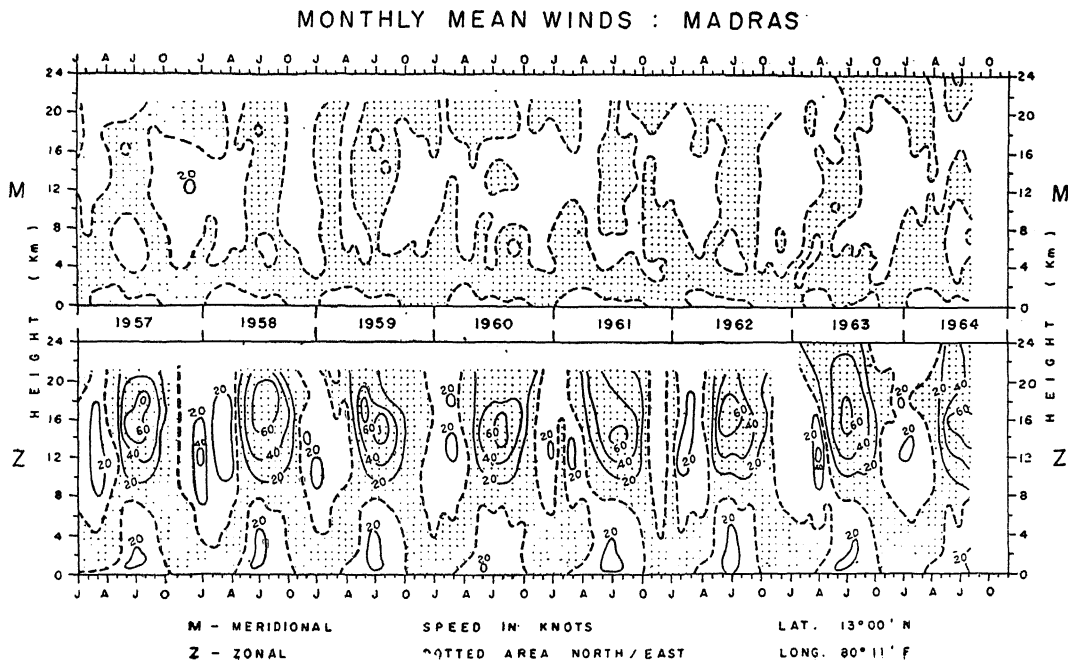
with the two well-defined seasons—Summer and Winter—into which the year as a whole can be divided. Over Trivandrum, the southernmost station, the zonal flow in the lower troposphere up to 6/7 km. consists of westerlies from May to October and easterlies from November to

MONTHLY MEAN WINDS : NAGPUR

M — MERIDIONAL   SPEED IN KNOTS   LAT. 21°26′N

Z — ZONAL   DOTTED AREA NORTH/EAST   LONG. 79°03′E
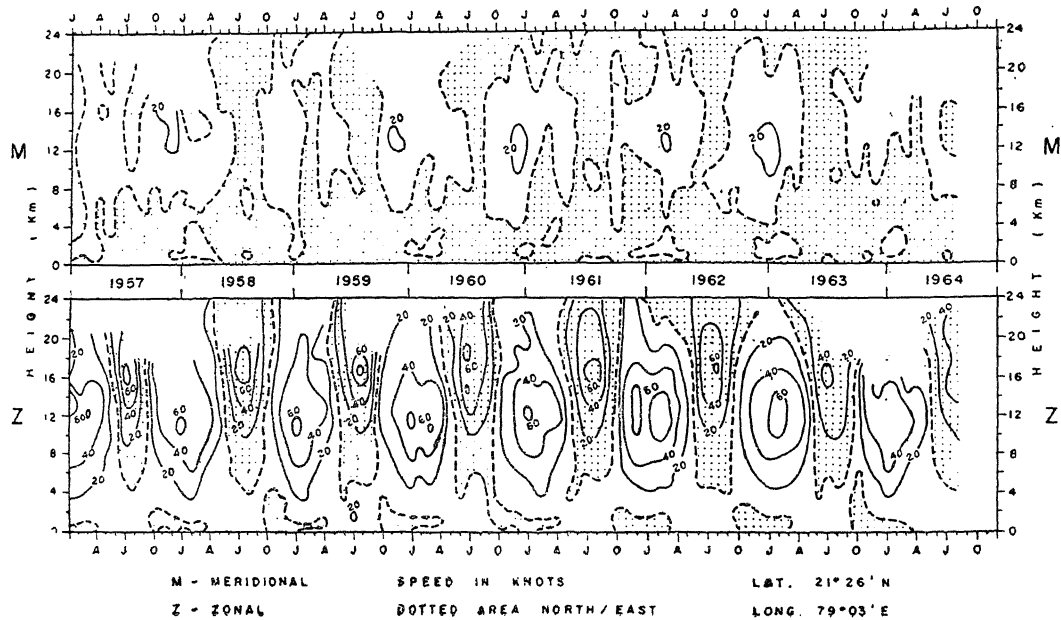
FIG. 5.

MONTHLY MEAN WINDS NEW DELHI

M — MERIDIONAL   SPEED IN KNOTS   LAT 28°35′N

Z — ZONAL   DOTTED AREA NORTH/EAST   LONG 77°12′E
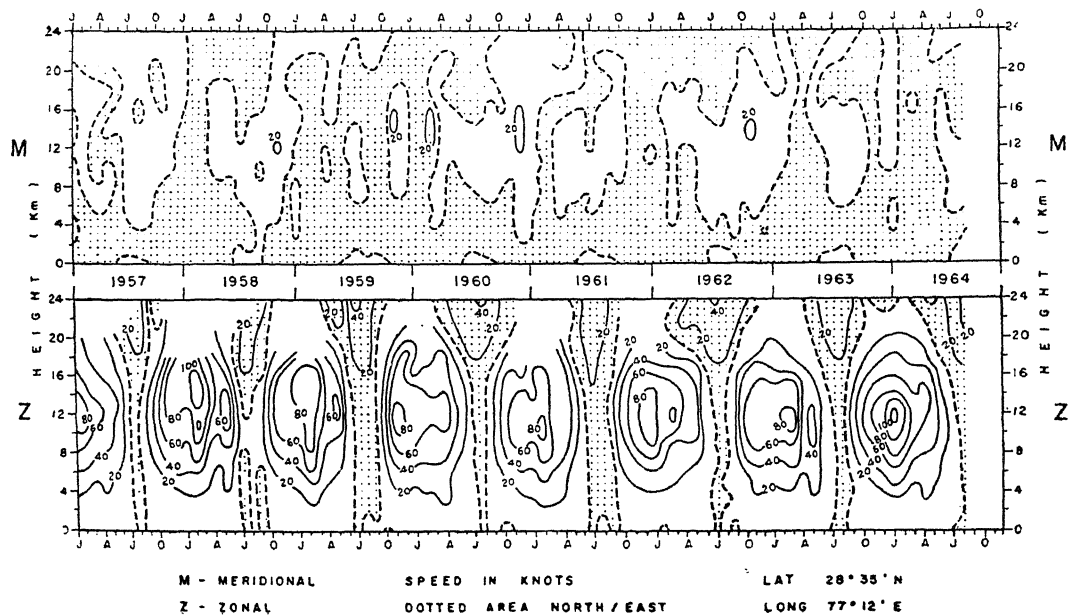
FIG. 6.

April. During the south-west monsoon months of June, July and August westerlies in the lower troposphere exceed 20 knots between 1 and 4 km. In the upper troposphere the flow is mainly easterly. However, spells of westerlies occur in the months December to April. The westerly flow shows appreciable fluctuations from year to year. The easterlies are organised and regular, and attain maximum speed exceeding 60 knots between 14 and 16 km. in the monsoon months of June, July and August. The lower stratospheric westerlies noticed during the period January to April in 1962 are replaced by easterlies in the following year, but are noticed again in 1964 in conformity with the recently discovered biennial oscillation of zonal winds at equatorial latitudes.

3.1.2. The zonal flow over Madras is generally similar to that over Trivandrum with some differences. The westerly regime in the upper troposphere is more pronounced and the zonal westerlies are stronger, the mean speeds exceeding 40 knots in some years. The easterlies attain their maximum speed at 16 km. level in the south-west monsoon months.

3.1.3. At Nagpur the westerly and easterly regimes are nearly equally prominent. Upto 3/4 km. weak easterlies occur in the months October to March/April and westerlies in the remaining months. At higher levels in the troposphere westerlies prevail during October to April/May and easterlies during the remaining months. The maximum speeds of the monthly mean upper tropospheric easterlies and westerlies reach 60 knots. The westerlies attain maximum strength at 11 km. in January/February and the easterlies at 17/18 km. in July/August.

3.1.4. The zonal flow in the troposphere over Delhi is westerly in all the months of the year except July and August when weak easterlies prevail. The zonal westerlies attain their maximum speed of 80/100 knots in the winter months of January/February at the level of 11/12 km. There are variations from year to year not only in the value of the maximum but also in the month in which the highest mean speed is reached. The speed and duration of the easterlies increase from 16 to 24 km. in the stratosphere.

3.2. *Meridional Circulation*

3.2.1. The meridional flow in the lower troposphere up to 3 km. is predominantly northerly at Trivandrum. At Madras this lower layer of northerlies extends up to 4 km. However, below 2 km. southerlies occur from February to October. At Nagpur the lower tropospheric layer of northerly winds extends up to 5/6 km. with pockets of southerlies up to about 3 km. in the months of January to April. At Delhi the meridional circulation continues to be predominantly northerly up to about 6 km. except for a shallow layer of southerlies confined to the first 1 to 2 km. during the south-west monsoon months June to September.

3.2.2. Above 4 km., the meridional flow over Trivandrum consists of alternating northerly and southerly regimes, the northerlies being prominent in the summer months and the southerlies in the winter months. Nearly similar features are noticed at Madras and Nagpur. Over Delhi on the other hand the meridional flow in the upper troposphere is predominantly southerly in the summer monsoon months and northerly in the winter months. At all the stations the meridional circulation is not only much weaker than the zonal circulation, but shows larger fluctuations from year to year.

A detailed report of our studies will be published elsewhere.

THE LIMITING MEMBRANE OF THE CHROMOSOME

(MISS) N. K. MANGALANGI, S. SUBRAMANYAM, S. ROYAN-SUBRAMANIAM AND
M. K. SUBRAMANIAM

Cytogenetics Laboratory, Department of Biochemistry, Indian Institute of Science,
Bangalore-12

THE accidental discovery that the chromonemata could be disorganized leaving the pellicles of the meta- and ana-phase chromosomes intact led to the suggestion that it is such a limiting membrane that gives the chromosome its morphological integrity.[1] This was a revival of the classical view of chromosome structure.[2-4] While scanning such preparations the impression obtained was that the limiting membranes of the chromosomes play a role in the formation of the nuclear membrane at telophase (see Photos 7-7 B, Subramaniam and Royan[1]). Mazia's[5] illustration of anaphase chromosomes having a membrane comparable in structure to the nuclear membrane (his Fig. 75) confirmed such a possibility.[6] Levan[7] records that when the two metaphase chromatids in the c-pairs of mouse ascites tumour cells were surrounded by a common pellicle, he obtained the impression that such a pellicle may get transformed directly into the nuclear membrane.

A perusal of the earlier literature reveals a lack of distinction between the pellicle and the matrix. The "sheath" described by Metz[8] presumably includes both these regions in meta- and ana-phase chromosomes. This confusion in the connotation and usage of the terms has already been discussed by others.[2,3,9] In most cases the presence of a chromosomal membrane has only been inferred[2] or deduced.[9] Actual demonstrations of such membranes are rather few.[1,4,6,10-13]

The disagreements on the question of the presence of a matrix and a pellicle stem form the differences of opinion as to the stage of division at which they could be located and studied. Theoretically, a chromosome may be expected to have a limiting membrane only after the disappearance of the nuclear membrane. In *Podisma* it is the I meta- and ana- phase chromosomes which were reported to have matrices and limiting membranes.[10] The denial of their presence[14] based on observations on meiotic prophase chromosomes does not appear, therefore, to be convincing.

Using a micro-manipulator D'Angelo[15] demonstrated the presence of a limiting membrane for the living salivary chromosomes. Corroboration of its presence is available from fluorescence microscopy.[16] These records have to be viewed as a class apart in the context of the absence of any such membrane in lampbrush chromosomes.[17] As indicated by Metz[8] the role of the chromosomal "sheath" is to insulate it from the surrounding cytoplasm during the mitotic movements.

At a time when the chromosomal matrix was suspected to be Feulgen-positive,[3,9] McClintock[18] correlated the formation of a matrix with the dissolution of the nucleoli and suggested that a part of the nucleolar matter may take part in its formation. The above possibility finds support in the recent suggestion[19] that the metaphase chromosome may act as a vehicle for the transport of nucleolar material. Apart from the DNA, the chromosomes are known to contain RNA, phospholipids,[20] histone and non-histone proteins capable of selective removal.[21] In the above context the presence of a matrix reported recently from electron micrographs appears rather interesting.[22]

The observations presented below are from the meristematic cells of *Allium cepa* and the testes of *Pœcilocerus pictus*. The methods of handling were only slightly different. While the root-tips of the germinated bulbs of *A. cepa* were dipped in a beaker of boiling water, the testes were transferred to a tube of water kept in a beaker of boiling water. The duration of exposure was one minute for the root-tips and 5 minutes for the testes. The root-tips were processed as hæmatoxylin squashes without any fixation or hydrolysis. The testes, on the other hand, were stored in acetic alcohol (1 : 3) overnight to remove the fat present as well as harden the tissue and then processed after hydrolysis in N HCl at 60° C. for 6 minutes, either as hæmatoxylin or Feulgen squashes.

Photo 1 is of a metaphase from *A. cepa*. Each chromosome is seen to have a distinct limiting membrane. Attention is invited to the fact that the pair of chromatids are enclosed within a single pellicle (Photo 2). An anaphase is presented as Photo 3. The enlargement

PHOTOS 1-8. Photos 1-4. Root-tips of *Allium cepa* exposed to boiling water. Hæmatoxylin squashes. Photo 1. Metaphase, × *ca.* 1,400. Photo 2. Enlargement of the chromosomes from Photo 1 (arrow), × *ca.* 5,200. Photos 3-4. Anaphase chromosomes. Photo 3, × *ca.* 1,400. Photo 4, × *ca.* 2,850. Photos 5-8. Testes of *Poecilocerus pictus* exposed to boiling water. Acetic alcohol fixation. Photos 5-7. Feulgen—light green squashes. Photo 8. Hæmatoxylin squash. Photo 5. Gonial metaphase, × *ca.* 2,500. Photo 6. Enlargement of two chromosomes seen in Photo 5 (arrow), × *ca.* 4,650. Photo 7. Metaphase I, × *ca.* 1,050. Photo 8. Metaphase 1, × *ca.* 2,150.

(Photo 4) of the upper cluster in the above micrograph shows each anaphase chromosome having a well-defined limiting membrane.

The gonial chromosomes of *P. pictus* also have distinct chromosomal pellicles (Photos 5 and 6). These appeared faintly positive in Feulgen preparations (Photo 7). A possible explanation for such a reaction is that the DNA released by the denaturation of nucleoproteins may lie apposed to the pellicle. Evidence has already been presented that the granules resulting from the disorganization of the chromonemata may arrange themselves on the inner surface of the pellicle (Photos 2–2 B, Subramaniam and Royan[1]). When the testes exposed to hot water and fixed in acetic alcohol were stored in 70% alcohol for 10 days and then processed as hæmatoxylin squashes, the limiting membranes of the bivalents at metaphase I enclose a matrix which is granular at its periphery (Photo 8). In the absence of such storage the matrix appears non-granular (Photo 7).

The chromonemata could be revealed by a variety of techniques.[1,4,23] The unstained spaces within the coils of the chromonemata represent the matrix.[2] Such a positional relationship is also emphasized in the recent report based on electron micrographs.[22] One of the methods used to reveal the chromonemata is exposure of cells to hot water.[24-26] This procedure produces a reorientation of the chromonemata and matrix within the pellicle.[4] In fact, such a reorientation appears necessary for a demonstration of the pellicle. The micrographs presented would emphasize that plant and animal chromosomes have distinct limiting membranes during mitotic and meiotic meta- and ana-phases.

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LETTERS TO THE EDITOR

ON THE LIFETIME OF THE 396 Kev. LEVEL OF Lu-175

THE decay scheme[1] of Yb-175 (with a half-life of 4·2 days) principally consists of levels in Lu-175 at energies 114, 251 and 396 Kev. The 114 and 251 Kev. levels are identified as the first and second excited rotational states with spins 9/2 + and 11/2+ respectively. The 396 Kev. level is identified as an intrinsic level with spin 9/2 −. The large M 2 admixtures observed in the E 1 transitions from the 396 Kev. level confirm the fact that the E 1 radiation is forbidden by the asymptotic quantum number selection rules, while the M 2 is allowed. In the present experiment, the transition probabilities obtained by the lifetime measurement of the 396 Kev. level, are compared with the estimates of the Nilsson's Strong Coupling model.[2]

The equipment[3,4] essentially consists of two scintillation spectrometers arranged in triple coincidence. The measurement of the lifetime of the 396 Kev. level is carried out using anthracene scientiatlor for beta detection and a NaI(Tl) crystal for gamma detection. The instrument has a resolving time of 2·3 ns for Co-60 source, and the slopes correspond to half-lives of 0·26 ns.

The isotope Yb-175 is obtained in a liquid form as ytterbium chloride in dilute HCl. It has an activity of 14·5 mC. in 1 c.c. out of which an activity of 2 mC. is attributed to the impurity Yb-169 having a half-life of 32 days. As the maximum energy of the beta component feeding the 396 Kev. level is only 70 Kev., the beta counter is placed very near to the source the distance being about 3 cm. The converter[4] assembly is kept in its maximum overlapping condition for the pulses. The gain of the amplifier in the fast channel corresponds to the calibration value of 0·909 ns/volt. The analyser in the beta channel is operated in the surplus mode. A 6% window is set to select the 396 Kev. gamma component in the gamma channel. The time spectrum is scanned and records are made for every voltage setting. The readings after deducting the chance rate are plotted as shown in Fig. 1. From Fig. 1 it can be seen that the half-life of the level is 3·32 ns. On repeating the experimental procedure, a value of 3·26 ns is obtained. With a possibility of an error of 5% due to inherent conditions of the instrument, those arising out

of the calibration, and measurement of cable lengths, the average value of the half-life of the 396 Kev. level turns out to be

$$T_{\frac{1}{2}} \text{ (396 Kev)} = 3·29 \pm 0·16 \text{ ns.}$$
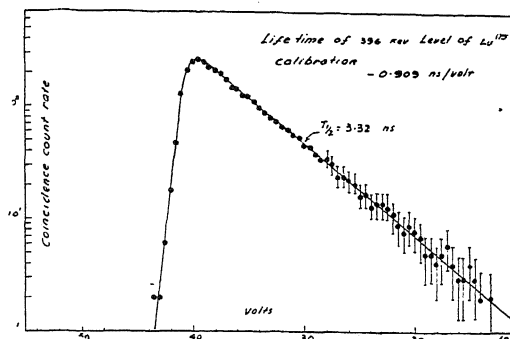
FIG. 1. Lifetime of the 396 Kev. level of Lu-175.

The present value is in good agreement with the previously reported values, 3·4 ± 0·3 (Vartapetian[5]), 3·1 ± 0·3 (Hauser et al.[6]) and 3·25 ± 0·1 (Berlovich et al.[7]).

From the value of the lifetime of the 396 Kev. level obtained in the present investigations, the transition probabilities are calculated and this calculation involves energy values, mixing ratios, conversion coefficients, and branching ratios which are taken from the work of Mize et al.[1] A comparison of these experimental results with the computed values on the basis of single particle (SP) model are tabulated as given in Table I. From this table it can be seen that the E 1 radiation is retarded by a factor of 10⁶ as expected by asymptotic selection rules. On the other hand, the M2 radiation is found to be allowed as expected by the selection rules. The small discrepancy in the case of M2 may be attributed to the errors possible in the quantities assumed for the correction of the transition probabilities.

In order to find whether the present experimental results can have a better fit with the predictions of the Strong Coupling model[2] for the E 1 transition probabilities from the intrinsic to the rotational levels, the transition probabilities are calculated and found to be: $P_N (E 1)_{396} = 1·180 \times 10^{10}$; $P_N (E 1)_{282} = 9·76 \times 10^8$ and $P_N (E 1)_{145} = 1·32 \times 10^7$.

Now, a comparison of the experimental values with those obtained above shows that the

TABLE I

Transition probabilities for the 396 Kev. level

Transition Energy (Kev.)	$a_{tot.}$	δ^2 ($= M\,2/E\,1$)	Relative Intensity	P (E 1) Expt.	P (E 1) S.P.	Hindrance Factor
396·3	0·0755	0·25	100	$9·334 \times 10^7$	$1·995 \times 10^{14}$	$2·135 \times 10^6$
282·5	0·0337	0·02	62	$7·408 \times 10^7$	$7·244 \times 10^{13}$	$9·779 \times 10^5$
144·9	0·12		5·9	$6·622 \times 10^6$	$9·779 \times 10^{12}$	$1·477 \times 10^6$
				P (M 2) Expt.	P (M 2) S.P.	
396·3				$2·336 \times 10^7$	$2·513 \times 10^7$	1·075
282·5				$1·482 \times 10^6$	$4·625 \times 10^6$	3·120

hindrance factors are: $N_H(396) = 126·2$; $N_H(282) = 12·96$; and $N_H(145) = 1·994$. From these values of the factors it can be seen that there is a reasonable agreement between the theoretical and experimental results as observed in several other odd A nuclei in the deformed region.

The Laboratories for   K. M. M. S. Ayyangar.
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Andhra University,   Swami Jnanananda.
Waltair, *February 3, 1965.*

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OXIDATION OF *n*-BUTANOL BY CERIC IONS IN AQUEOUS SOLUTION

Oxidations of various organic substrates— formaldehyde,[1] acetone and other ketones,[2] glucose and levulose,[3] mandelic,[4] lactic,[5] citric[6] and malonic acids,[7] ethanol,[8] methanol,[9] cyclohexanol,[10] glycerol[11] and polyvinyl alcohol[12]—by ceric ion have all been explained on the basis of homolytic fission of O—H or C—H bond in the substrate and electron transfer to ceric ion resulting in the formation of H^+, Ce^{3+}, and substrate-free radical; further reactions of the latter radical with Ce^{4+} bring about degradation to stable products. We have studied oxidation of butanols and propanols and present our results for oxidation of *n*-butanol as a typical alcohol. Oxidation of *n*-butanol by ceric perchlorate in the temperature range 10°–15° C, $[HClO_4] = 0·5$–2 M, ionic strength = 2·1 M in sodium perchlorate both under deaerated and undeaerated conditions has been studied. The reaction has been followed by determining the rate of ceric disappearance by titrimetry with excess of ferrous ion and back titration with standard ceric ammonium sulphate. Concentrations of ceric ion, *n*-butanol and hydrogen ion, initially added cerous ion, ionic strength and temperature have been employed as variables. The rate is first-order with respect to ceric ion concentration. The pseudo first-order rate constant obtained under conditions of [*n*-butanol] $\gg [Ce^{4+}]$ gives an order of *ca.* 0·5 for butanol. On the other hand plots of 1/Rate *vs.* 1/[*n*-butanol] as well as 1/Rate *vs.* 1/[H^+] are linear. Increase of ionic strength and initially added cerous ion have very little effect on the rate.

Our results may be explained on the basis of formation of ceric-butanol complex in 1 : 1 ratio and unimolecular decomposition of the complex as the rate-determining step. On the basis of the relationship

$$\text{Rate} = k_{obs.} [Ce^{4+}]_{Total} = k_t [\text{Complex}]$$

we get

$$\frac{1}{k_{obs.}} = \frac{1}{k_t} + \frac{1}{k_t K [B]} + \frac{Kh}{k_t K [B] [H^+]}$$

if k_t = theoretical rate constant; [B] = [Butanol]; K is the equilibrium constant for ceric-butanol complex and K_h is the hydrolytic constant for Ce^{4+}. From plots of $1/k_{obs.}$ *vs.* 1/[*n*-butanol] as well as $1/k_{obs.}$ *vs.* 1/[H^+] values of k_t, K_h and K have been evaluated at temperatures 10–15° C. Values of $\triangle H$ for K_h and K are 15·9 and 1·537 k. cals./mole respectively. The former value is in good agreement with that of 15·3 k. cals./mole reported by Hardwick and Robertson.[13] Values of $\triangle S$ for K_h and K are 56·83 and 11·61 e.u. respectively. Further, $k_t = 4·834 \times 10^{17}$ exp.

$(-26,760/RT)$ sec.$^{-1}$ and $A = (kT/h)$ e exp. $(20\cdot46/R)$ sec.$^{-1}$ have also been obtained.

We wish to conclude that our results may be explained on the basis of Ce^{4+} (aq.) and not CeOH^{3+} (aq.) as the active species for oxidation; fission of O—H bond of alcohol accompanied by electron transfer to Ce^{4+} leads to formation of n-butyraldehyde which is rapidly oxidised to stable n-butyric acid. A detailed paper consisting of experimental results, mechanism, etc., for oxidation of various alcohols by ceric ion will appear elsewhere.

Dept. of Physical Chemistry,   M. RANGASWAMY.
University of Madras,   M. SANTAPPA.
Madras-25, *February* 5, 1965.

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BUFFER AMPLIFIER FOR USE IN THE STUDY OF ELECTROCHEMICAL CELLS IN CONJUNCTION WITH GALVANOMETER RECORDERS

SEVERAL recorders are often required in big industries to record the various control parameters and it may not be feasible to opt for the best types of recorders that are very costly. Normally galvanometer type of recorders are preferred because of their simplicity in construction, robustness, easy maintenance and above all cheapness. The disadvantages of such recorders are : (a) large power requirement; (b) low input impedance, resulting in drawing of current from the system under study. Since a large current draw may disturb the electrodes under study, need arises often to convert the above into one having a high input impedance.

The present paper discusses the possibility of using an amplifier which acts as a buffer between the measuring device and the electrochemical cell under study. Here two circuits were successfully employed in conjunction with Metrowatt recorders type (No. 110868-German).

Both the types consist of differential (push-full) amplifiers of conventional design with the first two stages acting as the voltage amplifier and the second stage acting as current amplifier to power the recorder. In one of the circuits (Fig. 1) care had been taken to minimise the effects of mains fluctuations and zero drift by employing electronically regulated power supply. The above amplifier combined with the recorder can well be used for the recording of potentials in research work. A simpler circuit (Fig. 2) can also find much use in industries where the ultimate precision is not a stringent criterion; and can be used for routine recording of voltages corresponding to different parameters in industry.

It is also possible to connect low impedance voltage dividers preceding the recorder while

BUFFER AMPLIFIER FOR METROWATT RECORDER

ALL RESISTORS ARE 10%, 1 WATT

UNLESS OTHERWISE STATED

measuring large voltages. Provision has been made to adjust the amplifier characteristics to suit the different types of recorders.

BUFFER AMPLIFIER FOR METROWATT RECORDER

FIG. 2

The input current for driving recorders has been so low that a $50\,\mu A$ micro-ammeter is unable to detect any current drawn from the voltage source and the amplifier can drive a recorder requiring $4\,mA/volt$.

The buffer amplifiers are in use in our Institute for the past two years and are giving satisfactory performance with the Metrowatt Recorder type (Metrowatt Type No. 110868) in the voltage ranges 0-3 volts, and 0-7.5 volts.

Central Electrochemical   U. H. Narayanan.
     Research Institute,   S. B. R. Shenoy.
Karaikudi-3, S. India,   Y. Mahadevan.
March 4, 1965.   K. R. Sivaraman.

ACTIVITY COEFFICIENTS OF BERYLLIUM CHLORIDE IN MOLTEN BERYLLIUM CHLORIDE-SODIUM CHLORIDE

The fused salt system $BeCl_2$-NaCl is employed as bath for electrolytic production of beryllium metal. The electro-chemical behaviour in this solvent would, therefore, be of interest. Markov and Delimarskii[1] measured the e.m.f. of the cell :

$$Be/BeCl_2\,(x) + NaCl\,(1-x)/Cl_2\,(graphite)$$
$$(1)$$

as a function of mole fraction (x) of $BeCl_2$ in molten $BeCl_2$-NaCl at $500°$ C. For the calculation of thermodynamic parameters of the above system one needs the standard e.m.f. $(E°)$ of the formation cell :

$$Be/BeCl_2\,(Molten)/Cl_2\,(graphite),\,1\,atmp.$$
$$(II)$$

This cannot be determined experimentally because of the high volatility of beryllium chloride at this temperature.[2] There are other objectionable features common to experimental determination of the e.m.f. of formation cells of the above type as chemical interaction of the electrode with the molten electrolyte resulting in partly electronic and/or hole[3-4] instead of assumed purely ionic conductivity,[5] production of electrodes in non-standard states, deviations from isothermal conditions, electrode polarization, etc. Markov and Delimarskii obtained the $E°$ value by an extrapolation method which cannot be considered satisfactory. In this study the $E°$ values at different temperatures have been *calculated* from the standard free energy of formation $(\triangle G°)$ of $BeCl_2$ by using the equation :

$$- \triangle G° = nFE° \qquad (1)$$

where the symbols have the usual thermodynamic significance. The starting point in these calculations was the heat capacities at constant pressure (Cp) for the metal chloride, metal and chlorine, their temperature dependence having been expressed by the general equation.[6]

$$Cp = a + (b \times 10^{-3})\,T + (c \times 10^{-6})\,T^2$$
$$+ \frac{(d \times 10^5)}{T^2} \qquad (2)$$

where a, b, c and d are known numerical values. From $\triangle Cp$, $\triangle H_f°$, $\triangle S°$ and a knowledge of the properties of any phase transitions, the final form of equation for obtaining $\triangle G°$ is[7] :

$$\triangle G° = \triangle H°_{f, 298} - (2.303\,\triangle a)\,T \log T$$
$$- \frac{1}{2}\,(\triangle b \times 10^{-3})\,T^2 - \frac{1}{6}\,(\triangle c \times 10^{-6})\,T^3$$
$$- \frac{1}{2}\frac{(\triangle d \times 10^5)}{T} - T \triangle (B - a)$$
$$+ \triangle A \qquad (3)$$

The various quantities contained in it are fully discussed elsewhere.[7] This equation was used to compute $\triangle G°$ values at selected temperatures from which $E°$'s were then obtained by Equation (1). Thermal data computed by Glassner[6] were used ; calculations having been programmed with the aid of an IBM-1620 computor. $E°$ values in the temperature range 400 to $550°$ C. are presented in Table I ; the value at $500°$ C. was used to calculate the activity and activity coefficients of beryllium chloride in $BeCl_2$-NaCl from the available experimental data.[1]

TABLE I

Cell : $Be/BeCl_2/Cl_2$

Temperature (°C.)	410	430	450	470	490	510	530	550
E° volts (calculated)	1·903	1·890	1·877	1·863	1·850	1·837	1·824	1·812

Cell : $Be/BeCl_2 (x) + NaCl (1-x)/Cl_2$ at 500° C.

Mole fraction x_{BeCl_2}	0·70	0·60	0·50	0·40	0·33	0·30
Activity $(a \times 10^3)$	6·353	3·707	1·521	0·2931	0·03428	0·00826
Activity Coefficient $(\gamma \times 10^3)$	9·076	6·177	3·041	0·7326	0·1039	0·02754

The activity coefficients of beryllium chloride are found to be very low showing that it is highly complexed in its solution in sodium chloride. This supports the earlier observations of Schmidt[8] who also reported appreciable interaction between the components in this solution.

Department of Chemistry,   R. S. SETHI.
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GROWTH FACTOR IN LUCERNE (*MEDICAGO SATIVA* LINN.) LEAVES*

BOWLAND et al.[1] obtained evidence for the existence of an unidentified factor or factors in dehydrated lucerne for the growth of rats fed purified rations. Subrahmanyan and Sur[2] showed that desiccated lucerne leaf had spectacular supplementary relation to poor rice diet. It was not clear however whether the remarkable growth-promoting effect of lucerne was partly due to some unknown growth factor or entirely due to known dietary essentials such as protein, calcium, etc.

Peterson[3] showed that lucerne meal contained a saponin-like factor which depressed growth when fed to chicks in large doses. The inhibiting effect was counteracted when cholesterol was fed simultaneously.[3-5] It was felt that if lucerne leaf contained a new growth-promoting factor its presence could be demonstrated better if the growth-inhibiting effect of the saponin-like factor was counteracted by feeding cholesterol simultaneously. The present experiment was designed to establish if lucerne leaves actually contained any new growth factor for rats.

Twenty healthy albino rats were weaned when 28–30-day old and distributed into two groups strictly comparable with respect to age, weight, sex and litter. The control group received a stock synthetic diet, which was complete with respect to all known nutritional requirements. The test group received in addition to the synthetic diet, a homogenate of fresh lucerne leaves equivalent to 5% of diet on dry weight basis. The control group received a slurry of

filter-paper to the extent of 0·3% of the syntheic diet to provide fibre.

The stock synthetic diet consisted of : alcohol-extracted casein 20%, groundnut oil 10%, Hubbell Mendel[6] salt mixture 2%, cholesterol 1%, sucrose 20%, starch 46%, vitaminized starch 1% (containing vitamin B_{12} 0·6 mg., biotin 24 mg., folic acid 180 mg., thiamine hydrochloride 360 mg., choline chloride 18 gm., riboflavine 360 mg., pyridoxine 360 mg., niacin 480 mg., calcium pantothenate 480 mg., p-aminobenzoic acid 2·4 gm., inositol 4·8 gm., and menadionesodium bi-sulphite 600 mg. per 100 gm. starch). One drop of a solution of 500 mg. vitamin A-acetate, 2 g. α-tocopherol and 6 mg. calciferol in 100 ml. alcohol was given to each rat every day.

The experimental rats were fed *ad libitum* for a period of 7 weeks. The animals were weighed weekly and records of their diet intake were maintained.

The gains in weight of rats in the control and the test groups over a period of 7 weeks were 71·2 ± 3·76 gm.† and 73·5 ± 1·66 gm.† respectively. The corresponding diet intakes were 302 ± 5·36 gm.† and 325 ± 3·64 gm.† respectively.

It would be seen, therefore, that the rates of growth of the animals in the two groups were almost identical even when the possibility of any growth-inhibiting effect of the saponin-like factor in lucerne meal was ruled out by simultaneously feeding cholesterol. Lucerne leaf does not appear, therefore, to contain any new growth factor for rats. The spectacular growth-promoting effect of lucerne when fed as supplement to poor rice diet[2] appears, therefore, to be entirely due to supplementation of known dietary essentials.

G.S.V.M. Medical College, N. C. Sharma.
Kanpur, *January* 8, 1965. V. M. Bhatnagar.
                              B. K. Sur.

† Standard Error of the mean.

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ILMENITE FROM EAST COAST BEACH SANDS

WITH the objective of evaluating the usability of east coast limentite in the production of ferro-titanium and other ferro-alloys, ilmenites separated from the richest heavy mineral concentrates in the beach sands at three points on the coast of Andhra Pradesh, is analysed. Heavy minerals are concentrated by tapping on a cardboard, washed, dried and screened with 35-mesh A.S.T.M. sieve. Over 60% of the magnetite present is removed, using a small 'Alnico' magnet wrapped in cellophane. The sample is then run through Frantz Isodynamic magnetic separator with 30° forward slope and 15° side slope at 0·1 ampere current, to remove the rest of the magnetite. The resulting non-magnetic fraction is again run through the Isodynamic separator with the same slope settings as before, but at 0·25 ampere current, when ilmenite separates out on the magnetic side. The specific gravity of the mineral separate thus obtained, which is estimated to be about 90% pure, is determined.

Three ilmenite samples are analysed for TiO_2, FeO and Fe_2O_3 contents.[1,2] While determining titanium by the tannin precipitation method of Schoeller and Powell,[1] the titanium dioxide obtained by igniting the tannin-titanium precipitate is fused with sodium bisulphate and the precipitation carried out once again to ensure that the titania finally weighed is free from iron which generally gets precipitated by tannin. The original filtrate is tested for complete precipitation of titanium. Ferrous and total iron are first determined in the same aliquot of sample according to the procedure cited by Codel,[2] and ferric iron is found by difference. The analyses for TiO_2, FeO and Fe_2O_3 are duplicated and the results are reasonably close. Spot tests indicate that Cr_2O_3, V_2O_5 and P_2O_5 contents are less than 0·05%. Table I gives the detailed location and specific gravity of the samples. The results of the present analyses of east coast ilmenites along with corresponding reported values for ilmenites from the west coast of India and elsewhere in the world are given for comparison in Table II.

According to Barksdale,[4] ferro-carbon-titanium is manufactured by smelting titaniferous iron ore in electric furnace with a flux and coke at 500 amperes and 50-60 volts. A typical charge may consist of 100 parts of ore containing about 67% ferric oxide and 14·4% TiO_2, 16 parts of limestone for fluxing and 30 parts of carbon as coke. While the east coast ilmenites

TABLE I
Detailed location and specific gravity of the ilmenites analysed

Sl. No.	Sample number	General location	Sheet number	Grid location	Specific gravity
1	SR-BM$_4$/61	Near the mouth of river Vamsadhara, ½ mile E of Revu Ampalam	74 B/3	RE 781283	4·69
2	G-175/60	Near the mouth of river Nagavali ¼ mile E of Khazipeta	65 N/16	E 575117	4·73
3	G- A/63	Near Waltair, ¼ mile E of East Point Rest House	65 O/6	RJ 872490	4·76

TABLE II
Comparative study of east coast ilmenites with ilmenites elsewhere

Sl. No.	Location	% TiO$_2$	% FeO	% Fe$_2$O$_3$	% Fe$_2$O$_3$/FeO	SiO$_2$
1	Vamsadhara mouth ..	52·23, 51·98	35·99 37·06, 36·36	8·56, 9·72	9·23, 0·27	0·6, 0·5
2	Nagavali mouth ..	51·38, 52·28	39·39, 38·81	8·92 9·27	0·23, 0·24	0·6, 0·4
3	Waltair ..	48·11, 47·81	31·11, 31·41	20·92, 19·87	0·67, 0·63	0·4, 0·6
4	Chavara, Travancore ..	60·8	10·43	24·30	2·33	0·8
5	Manavalakurichi, Travancore ..	53·60, 54·30	26·70, 26·00	14·20, 15·50	0.53, 0·6	1·5, 1·4
6	Brazil ..	48·3	32·4	16·6	0·51	1·4
7	Malayan tin-placer residues ..	53·4	32·6	8·2	0·25	..
8	Albemarle Sound, North Carolina, U.S.A.	50·5	34·9	10·4	0·3	..

(1 to 3—Author; 4—Rao *et al.*[3]; 5 and 6—Barksdale[4]; and 7 and 8—Gillson[5])

are suitable for ferro-carbon-titanium and other ferro-alloys manufacture, the feasibility of the production of these and other alloys of titanium on an industrial scale can only be worked out after a detailed techno-economic survey of the project.

The financial assistance of the Department of Atomic Energy during the progress of this work is thankfully acknowledged.

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ON THE DISCOVERY OF GRAYWACKES IN THE PRE-CAMBRIANS OF RAJASTHAN FROM NEAR UDAIPUR CITY

None of the earlier workers reported true graywackes from the Pre-cambrians of Rajasthan. Heron[1] has, however, referred casually to (i) the resemblance of the quartzites (or merely their roughness) of the area west of Delwara (24° 47′ : 73° 45′) and N.E. of Rama (24° 44′ : 73° 41′) with the graywackes and (ii) "a grade of sediment describable as schistose graywacke" in the triangular area on the south of Banas river. The present author came across graywackes for the first time during the course of his geological mapping around Udaipur between the years 1958-64, and the note gives a preliminary account of these rocks.

Graywackes have been defined differently and their formation ascribed to different environments by various authors.[2] The rocks under study, however, fulfil the characteristics of graywackes stated by Pettijohn[3] and Carozzi.[4]

The graywackes are encountered within the Aravallis around the city of Udaipur, e.g., south of Udaipur Railway Station and near the village of Balicha (24° 31′ : 73° 40′) (Fig. 1). They occur as hard and resistive bands amidst the shales, phyllites and sericite schists of Aravallis. They trend roughly N-S parallel to the foliation strike of the associated rocks. They dip usually at high angles and are even vertical at several places. The thickness is variable ; ranging between a few inches to tens of feet and even more.

The rocks are dominantly black in colour, massive, compact, very hard, highly jointed and break with a sub-conchoidal fracture. Graded bedding and slump structures are common but cross-bedding is absent. Detrital quartz and feldspar grains are evident to the unaided eye.

Veins of quartz and calcite are found invading the graywackes.

FIG. 1.

GEOLOGICAL SKETCH CUM LOCATION.

INDEX   SCALE 1" = 4 MILE

DELHI

ARAVALLIS

- CONGLOMERATE
- GRANITE
- LIMESTONE
- QUARTZITE
- PHYLLITES WITH BANDS OF GRAWACKES
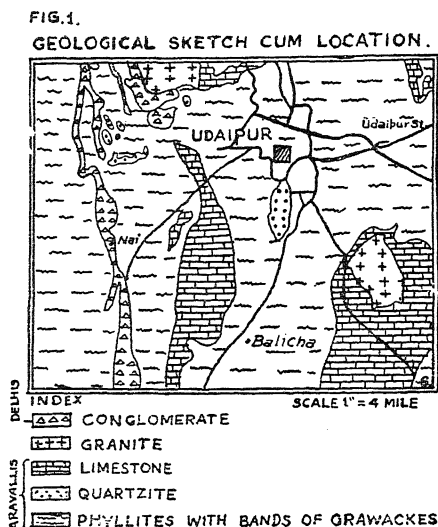
FIG. 2

Several varieties, named below, have been recognized under the microscope. Among them the feldspathic type is most dominant.

(a) Feldspathic graywackes (coarse and medium-grained);

(b) Lithic graywackes (coarse and medium grained);

(c) Fine-grained graywackes with no metacrysts.

(d) Quartz graywackes (medium and fine grained);

(e) Graywackes with calcite megacrysts.

The most important textural feature is the penetration of matrix minerals like biotite and chlorite flakes in the body of quartz megacrysts, thereby giving rise to comb-like appearance or "chevaux-de-frise" of Greenly. These rocks are poorly sorted and contain fragments of sedimentary and metamorphic rocks.

The matrix consists of micro-crystalline aggregate of quartz, folia and flakes of biotite, chlorite and sericite, feldspar, actinolite and iron ore. Tourmaline, calcite and epidote occur as subordinate constituents. The megacrysts are angular to sub-angular grains of plagioclase (oligoclase to labradorite) (Fig. 2), quartz, calcite and rarely of the fragments of shale, phyllite and quartzite. Microcline is absent whereas orthoclase is present occasionally. The tabular and angular plagioclase metacrysts look mostly clear and fresh but slight cloudiness may be seen.

The poor sorting, poor rounding and the presence of detrital matrix instead of chemical cement suggest short transport. The presence of mixed fine and coarse-grained detritus, graded bedding and marked variation in the thickness of interbedded phyllites indicate the introduction of sediments by turbidity currents of varying intensity. The high feldspar content suggests deposition in narrow and rapidly subsiding geosynclines.[5]

Post-Graduate Department   M. K. PANDYA.
of Geology,
University of Rajastan,
Udaipur, *November* 3, 1964.

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ON FOSSIL SHARK TEETH FROM THE BAGH BEDS OF AMBA DONGAR AREA, GUJARAT STATE*

THE present communication records the discovery of a very rich assemblage of fossil shark teeth from the Bagh Beds exposed in the Amba Dongar area between Mongra (22° 0′ 30″ : 74° 02′ 30″) and Moti Chikli (22° 01′ 30″ : 73° 05′), south of Kawant (22° 05′ 30″ : 74° 03′ 30″) in the Baroda District of Gujarat State. The credit of discovering the fossil fish teeth in this area goes to M. L. Parimoo, Geological Survey of India, while the actual recognition of the fauna is due to the present author. The results recorded here have accrued from an examination of a large collection of fossil shark teeth made by the author.

This area was first geologically mapped by Bose (1884) and later by Mahajan (1961). Almost all the fossils described below have been collected from the Oyster Bed zone of the Bagh Beds, which essentially consists of highly fossiliferous limestones.

The author has identified 12 species, including 2 new species and 1 new variety, of sharks, a check list of which is given below : *Scapanorhynchus baghensis* Verma, n.sp., *S. subulata* (Agassiz), *Lamna appendiculata* (Agassiz) var. *mongrœnsis* Verma, n. var., *L. marginata* (Egerton), *L. nana* (Egerton), *L. basalis* (Egerton), *L. cf. libyca* Quaas, *Oxyrhina hastalis* Agassiz, *Corax pristodontus* Agassiz, *Ginglymostoma sokotense* White, *Carcharius (Prinodon) egertoni* (Agassiz), and *C. (P.) ambadongarensis* Verma, n.sp.

A brief description of the new species and variety is as under :

Scapanorhynchus baghensis Verma, n.sp. (Figs. 1 a-4).—Teeth fairly large, sigmoidal in profile, tip twisted outwards (Fig. 1) : outer coronal face smooth (Figs. 2-3) and gently convex ; inner coronal face very convex and finely, but prominently, striated, striations disappear towards the pointed end and also towards the lateral margins (Figs. 1 a-b, 4) ; roots fairly large and deeply bifurcated (Fig. 2); lateral edges sharp and without lateral serrations (Fig. 1 a) ; the anterior teeth (Figs. 1 a-3) without lateral denticles and posterio-lateral teeth (Fig. 4) with a single pair of sharp lateral denticles. The teeth differ in size, form and proportions according to their positions in the jaws, but all show the characteristic shape and striations on the inner coronal face.

Carcharius (Prinodon) ambadongarensis Verma, n.sp. (Figs. 20 a-b).—Teeth of moderate size, broad, triangular with sharp and pointed apex ; outer coronal face flat (Fig. 20 a); inner coronal face very convex (Fig. 20 b); both faces smooth and polished; anterior cutting edge arched and smooth; posterior cutting edge prominently serrated from base to apex.

Lamna apendiculata (Agassiz) var. *mongrœnsis* Verma, n. var. (Figs. 6-7).—Teeth stout, upright; principal cusp large conical with two well-defined fairly broad, sharply pointed, lateral cusps, one on either side; outer coronal face almost flat with a few vertical folds immediately above the root; inner coronal face markedly convex and smooth; lateral edges sharp and without any serrations; roots fairly broad, laterally expanded and deeply bifurcated.

The remaining species have already been described in detail by the earlier workers.

Besides the above-mentioned shark teeth the author has collected, in association with them, a large number of ammonites, echinoids, lamellibranchs, gastropods and bryozoans.

The fossils recorded above, from the Amba Dongar area, show distinct relationship to the Cretaceous of South India, and their presence reduces the disparity which was thought by some to exist between the faunas of the Coromandal coast and the Narbada valley. Of these shark teeth *S. baghensis* Verma (= ? *Enchodus serratus* Eg.), *S. subulata* (Ag.) (= *Odontospis constrictus* Eg. and *O. oxyprion* Eg.), *L. marginata* (Eg.) (= *Otodus marginatus* Eg.), *L. nana* (Eg.) (= *Otodus nanus* Eg.), *L. basalis* (Eg.) (= *Otodus basalis* Eg.) and *Corax pristodontus* Ag., have been recorded from the Utatur and Ariyalur stages of the Cretaceous of Trichinopoly and Pondicherry areas by Egerton (1845) and Stoliczka (1873). *C. (P.) egertoni* (Ag.) and *Ginglymostoma sokotense* White have been reported from the Miocene of Burma by Stuart (1910) and Eocene of Nigeria by White (1934) respectively. The genus *Ginglymostoma* has so far not been recorded from horizons older than Mæstrichtian. However, most of these sharks range in age from Cenomanian to Senonian. Taking these facts into consideration the Bagh Beds may range in age from Cenomanian to Mæstrichtian.

The author is deeply indebted to Shri V. R. Khedkar, Director, Southern Region, and Dr. A. P. Subramanyam, Superintending Geologist, for their keen interest and to Shri M. L. Parimoo for his help in the field.
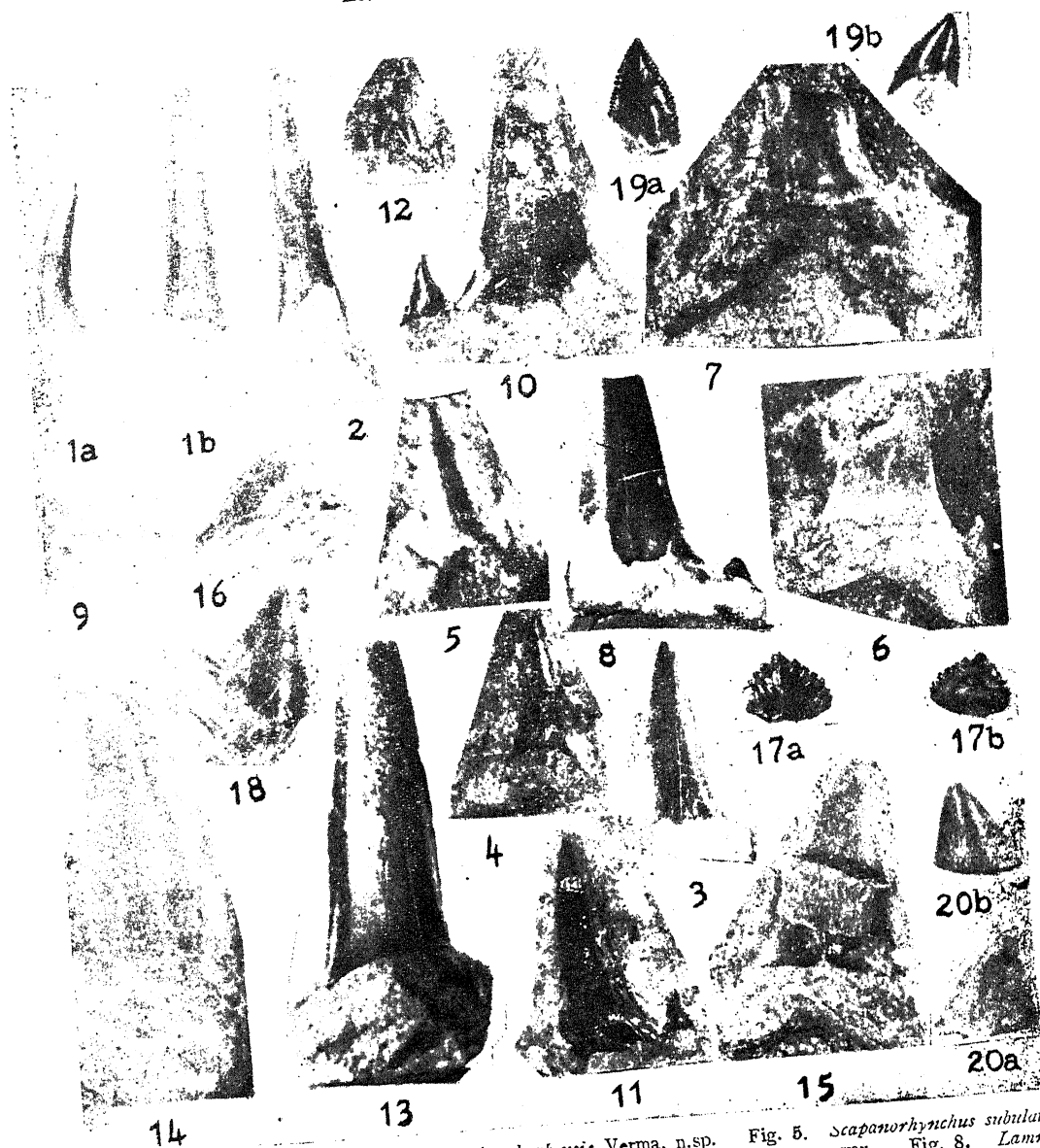
FIGS. 1–20. Figs. 1-4. *Scapanorhynchus baghensis* Verma, n.sp.   Fig. 5. *Scapanorhynchus subulata* (Agassiz).   Figs. 6-7. *Lamna apenticulata* (Agassiz) var. *mongrænsis* Verma, n. var.   Fig. 8. *Lamna marginata* (Egerton).   Fig. 9. *Lamna nana* (Egerton).   Figs. 10-11. *Lamna basalis* (Egerton).   Fig. 12. *Lamna cf. libyca* Quaas.   Figs. 13-15. *Oxyrhina hastalis* Agassiz.   Fig. 16.   *Corax pristodentus* Agassiz. Fig. 17 *a-b*. *Ginglymostoma sokotense* White.   Figs. 18-19 *b*. *Carcharius (Prinodon) egertoni* (Agassiz). Fig. 20 *a-b*. *Carcharius (Prinodon) ambadongarensis* Verma, n.sp.   (Figs. 1-3, × 1. Figs. 4-20, × 2).

K. K. VERMA.

Palæontological Division,
Geological Survey of India,
Southern Region, Hyderabad-28,
December 9, 1964.

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ON THE DISTRIBUTION OF ALKALINE PHOSPHATASE AMONG NEURONS OF PEDAL GANGLION OF *LAMELLIDENS MARGINALIS* (LAMARCK)

PEDAL ganglia taken from the living *Lamellidens* were fixed in formol-calcium[1] and the sections were cut at 10 μ. The sections were processed through Gomori's alkaline phosphatase technique.[1]

In the neurons the enzymatic activity was seen in the nuclei only—the nucleolus (arrow, *nu*) and the nuclear membrane (arrow, *n*) in particular were notable locations. The cytoplasm as well as the cell walls did not reveal enzymatic activity. The fibres (arrow, *nf*), lying between the neurons, gave positive reaction for the enzyme.

strated the activity of alkaline phosphatase on the neuronal surfaces. On the other hand the Purkinje cells of rat do not reveal enzymatic activity at their surfaces.[6] It is interesting to note that the pedal ganglion cells differ from the spinal ganglion cells of rats as far as the topography of the enzymatic distribution on the surface of the neurons is concerned. The absence of alkaline phosphatase at the surfaces of the pedal ganglion cells simply suggests that the enzyme, unlike its role in the rat spinal ganglion cells, is not taking part in the process of permeability across the cell membranes.

The author is grateful to Dr. H. B. Tewari for his constant help and encouragement.

Dept. of Zoology,   MOHAN PRAKASH GUPTA.
Udaipur University,
Udaipur, Rajasthan, October 9, 1964.
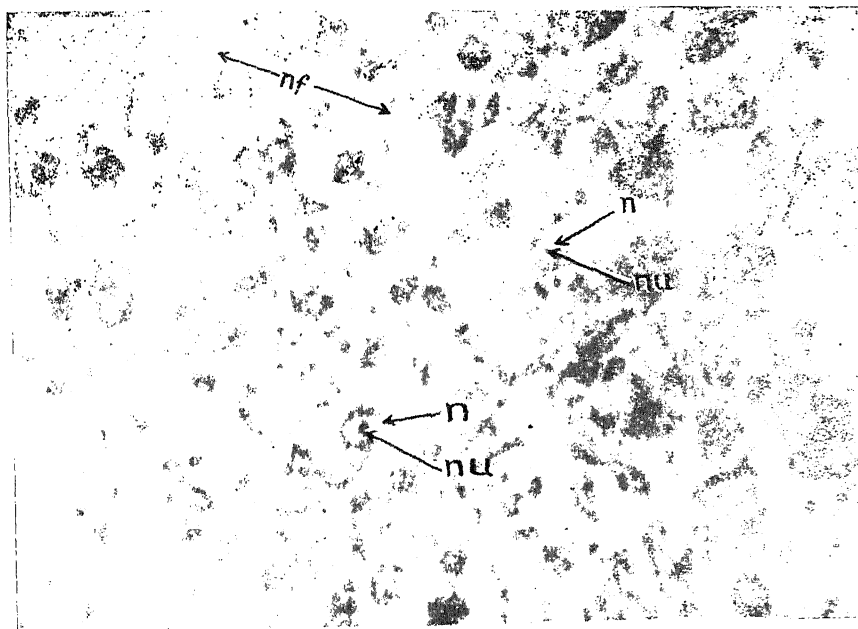
FIG. 1. Photomicrograph of a section of pedal gadglion of *Lamellidens marginalis* showing localization of alkaline phosphatase in the nuclear membrane (arrow, *n*), the nucleoli (arrow, *nu*), and the fibres (arrow, *nf*), × 1,980.

The enzymatic reaction exhibited by the nuclei in different cells is a disputed one.[1,2] Some believe that the staining reaction at these sites does not demonstrate the true sites of the enzymatic activity while others have contested this view and are of the opinion that alkaline phosphatase plays an important role in the metabolic activity of the nuclear area.[3] It has also been suggested that alkaline phosphatase is concerned with the process of permeability across the cell membranes.[4] Tewari and Bourne[5] in the spinal ganglion cells of rat have demon-

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A NEW MALE NEMATODE *CORYDIELLA CORYDI* GEN. AND SP. NOV. FROM SPOTTED ROACH

THE authors in August 1964 collected nematode parasites from the spotted roach belonging to the genus Corydia. The nematodes collected belonged to several genera like *Schwenkiella* (Basir, 1956), *Hammerschmiditiella* (Chitwood, 1932), *Blattophila* (Cobb, 1920), but one male specimen which appeared to resemble the male of *Thelastoma*, on detailed study, could not be assigned to any one of the known genera of the family *Thelastomatidœ*. The authors established a new genus *Corydiella corydi* gen. *et* sp. nov., for the reception of the new form.
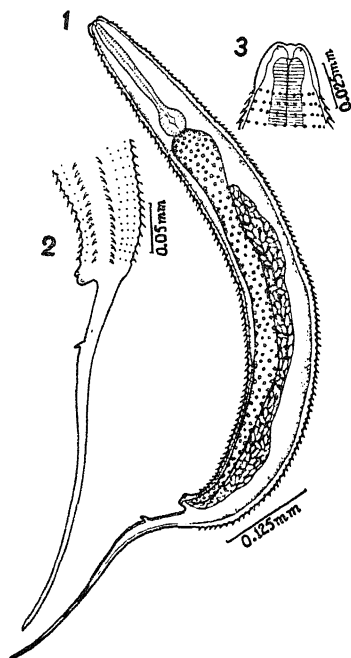
FIGS. 1-3. Fig. 1. Male entire, lateral view. Fig. 2. Male posterior end, lateral view. Fig. 3. Male anterior end, lateral view.

The specimen under study has a blunt anterior extremity and posteriorly ends in a long sharply pointed appendage. It measures 1·36 mm. in length and 0·105 mm. in its maximum thickness. The body surface excepting the anterior end and the caudal appendage is covered with backwardly directed spines which are arranged in transverse rows on the cuticular striæ. All the spines are almost of the same size except the two rows of spines on each of the lateral sides which are larger with curved ends starting from posterior to the oesophagus. Transverse striæ on the cuticle are found throughout the length of the body and are set at intervals of ·01 to ·012 mm. The mouth opens into a small vestibule which measures about ·01 mm. deep and ·005 mm. wide. The oesophagus is made up of a cylindrical corpus and a valvular bulb, the two joined together by a rather ill-defined isthmus. The corpus measures 0·152 mm. long by 0·023 mm. wide and the valvulated bulb is 0·037 mm. in diameter. The nerve ring was not observed. The intestine is wider than the oesophageal bulb in the anterior extremity and posteriorly it narrows evenly towards the rectum. The anus is 0·399 mm. from the tip of the caudal appendage. The testis extends considerably beyond the middle of the body and terminates into a reflex tip. Spicules are lacking but caudal papillæ are present. There are two pairs of papillæ placed round the anal opening, of which one pair is pre-anal and the other post-anal. The third papilla is not paired but solitary on the caudal appendage at about ¼ of its length from the anal opening.

SYSTEMATICS

In the general shape of the body and the disposition of the papillæ the worm resembles the genera *Thelastoma* (Leidy, 1849), *Schwenkiella* (Basir, 1956) and *Johnstonia* (Basir, 1956). But in any of the above-mentioned genera, there are no spines on the body in either males or females. The spines are present in certain genera of nematode parasites like *Hystrignathus* (Leidy, 1850), *Rondonema* (Artigas, 1926), *Indiana* (Chakrawarthy, 1943). But in all these genera, the spines are present only in females, the males of which are devoid of spines. However the male under discussion has distinct differences from all the known nematodes and represents a new genus. It is proposed to name it *Corydiella corydi* gen. *et* sp. nov. after the host.

GENERIC DIAGNOSIS

Thelastomatidœ.—Male bearing transverse rows of spines throughout the length of the body. All the spines are of the same size except two rows on each of the lateral sides which are larger and backwardly pointed. Buccal cavity is simple without any teeth. Oesophageal corpus cylindrical, isthmus not distinct, with a valvulated bulb. Testis single, tail slender, spicule absent. Caudal papillæ, one pre-anal and one post-anal pairs arranged round the anus and one single papilla on the tail.

Genotype : *Corydiella corydi*, parasitic in the gut of spotted roach *Corydia* sp.

Host :   *Corydia* sp.
Habitat :   Intestine.
Locality :   Hyderabad (A.P.), India.

Type specimens will be deposited in the museum of the Zoology Department, University College of Science, Osmania University.

The authors are indebted to Prof. S. N. Singh for encouragement and valuable suggestions in preparing this paper.

University College   P. NARAYAN RAO.
      of Science,   V. JAGANNATH RAO.
Osmania University, Nizam College,
Hyderabad, *December* 7, 1964.

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SOME NEW OBSERVATIONS ON THE KARYOLOGY OF *CHARA ZEYLANICA* KLEIN EX WILLD.

RECENTLY Griffin and Proctor[1] suggested a karyological basis for segregation of members of *Chara zeylanica* Klein ex Willd. producing 4-plated and 8-plated antheridia respectively. They found that 4-plated collections revealed a chromosome number of $n = 28$, while 8-plated collections showed usually $n = 56$, or exceptionally $n = 42$. On the basis of the above observations they concluded that 4- and 8-plated populations of *C. zeylanica* represent entities with chromosome numbers of $n = 28$ and $n = 56$ respectively within "zeylanica" complex. They suggested further work to show that exceptional plants having 8-plated antheridia with $n = 42$ might represent hybrids between populations having chromosome numbers of $n = 28$ and $n = 56$. Sundaralingam[2] reported earlier $n = 28$ in *C. zeylanica* from South India and his material also showed 4-plated antheridia, a fact which supports the view put forward by Griffin and Proctor.

During our cytological and cytotaxonomic investigations of charophytes of Uttar Pradesh (*cf.* Sarma and Khan[3,4]), we have come across material of *Chara zeylanica* with 4-plated

antheridia from 'Bawan Pokhra' and Saranath, localities in Varanasi District. Shield cells of the antheridia were lozenge-shaped (Fig. 1). A
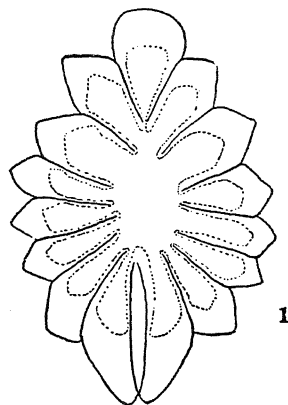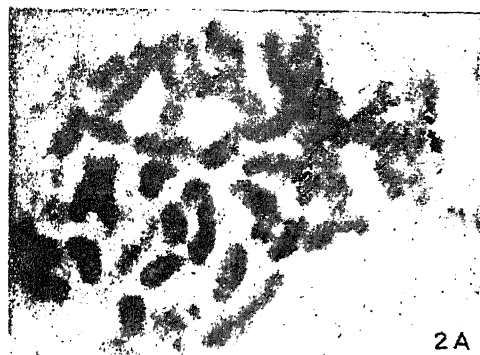
FIGS. 1-2. Fig. 1. *Chara zeylanica*—Shield cell of the 4-plated antheridium. × 150. Fig 2. (A) *C zeylanica*—Metaphase in polar view showing 42 chromosomes, × c. 2400. (B). Diagrammatic representation of chromosomes in the photomicrograph 2 (A).

karyological investigation of the material revealed a chromosome number of $n = 42$, both from dividing vegetative nuclei and from spermatogenous filaments. Godward's[5] iron-alum acetocarmine technique was used while

preparing the material for cytological study. The present observation that there exist populations of *C. zeylanica* possessing 4-plated antheridia with $n = 42$ (Fig. 2), does not favour a strict segregation of members with 4-plated and 8-plated antheridia on the basis of chromosome number alone as concluded by Griffin and Proctor. It further shows that within 4-plated populations, there exist plants with chromosome numbers both of $n = 28$ and $n = 42$. Further intensive work is needed on the karyology of *C. zeylanica* from different geographical regions, as it seems to be an interesting species where a number of chromosomal races seem to exist in its complex which may have evolved through hybridisation as well as polyploidy.

Department of Botany,   Y. S. R. K. SARMA.
Banaras Hindu University,   M. KHAN.
Varanasi-5, *November* 5, 1964.

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VIVIPARY IN *PINUS WALLICHIANA* A. B. JACKSON

THE phenomenon of vivipary is not common in angiosperms. It is rarer still in gymnosperms. Only a few workers have reported it in the latter group in plants such as *Ephedra trifurca*,[1] *Ginkgo biloba*,[2] *Podocarpus makoyi*[3] and *P. macrophyllus*.[4] The present note describes it for the first time in a Himalayan conifer, *Pinus, P. wallichiana* A. B. Jackson (syn. *P. excelsa* Wall.). The specimen shown in the accompanying photograph was collected on a botanical trip, on way from Pahalgam to Baisaran in Kashmir. Only one specimen was noticed in which the germination had taken place *in situ* within the cone of the parent plant. Attempts to collect more specimens were not successful. It is not easy to detect it also as the germinated seeds are almost completely covered by ovuliferous scales.

Normally, in this species full development of the embryo takes place in the seed while it is still on the parent plant and seed gets detached only after the embryo has been fully differentiated and seed had rested for several months. This is also the case in *Araucaria*. But in the present case the resting stage is absent and the embryos germinate on the parent plant while still on the female cone. Probably the germi-

nated embryos fall on the ground. A similar type is found occasionally in *Podocarpus macrophyllus* and *Ephedra trifurca* in gymnosperms and in *Avicennia alba* in angiosperms. In these the grown-up embryo is dropped out.

FIG. 1. A seedling that germinated viviparously. (*S*, seed; *T*, ruptured testa; *C*, cotyledons; *P*, plumule; *H*, hypocotyl; *R*, primary root.)

The present case looks to be similar to *Rhizophora mucronata* in which the viviparously germinated seed lies partly inside the fruit. However, only the elongated radicle (hypocotyl) emerges out of the fruit in the present case, while the cotyledons and plumule remain covered by the ovuliferous scale. It gets detached from the plant, probably as a seedling with elongated radicle and enlarged cotyledons get released through a crack in the ovuliferous scale. There is vital connection between fruit and embryo till it is dropped.

The authors are deeply indebted to Prof. T. S. Mahabale, Poona, for helpful criticism and suggestions. Thanks are due to Dr. V. Kaul, Srinagar, for suggestions.

Department of Botany,   M. K. WALI.
S.P. College, Srinagar,   S. N. TIKU.
Kashmir, *November* 19, 1964.

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CHROMOSOME NUMBERS IN ACANTHACEAE—I

CHROMOSOME counts of eight species belonging to three genera of Acanthaceæ, are reported here (Table I).

Name of the species	Chromosome No.
1 *Rostellularia serpyllifolia* Gamble ..	$2n = 18$
2 *Rostellularia rotundifolia* Nees ..	,, 18
3 *Rostellularia diffusa* Nees. var. *prostrata* Roxb. ex Clarke	,, 18
4 *Rostellularia procumbens* ..	,, 18
5 *Rostellularia vahlii* (Roth) Nees. ..	,, 18
6 *Dicliptera leonates* Dalz. ex Clarke ..	,, 48
7 *Dicliptera elegans* Dalz ..	,, 20
8 *Lepidagathis cristata* ..	,, 22

I am deeply indebted to Prof. M. R. Suxena, for providing research facilities in the department. My thanks are also due to Dr. Jafar Nizam for his guidance and valuable suggestions.

Cytological Laboratory,   JOGINDER KAUR.
Department of Botany,
Osmania University,
Hyderabad-7 (A.P.), *December* 15, 1964.

ALTERNARIA BLIGHT OF PYRETHRUM

NEES (1917) described a dematiaceous, Phæodictyosporous genus *Alternaria,* which was typified by *A. tenuis.* Wiltshire's (1933) record on species of the two allied genera *Alternaria* and *Macrosporium* includes *A. tenuissima,* while Neergard (1948) discussed at length the concept of the species *A. tenuis* Nees and Danish species of *Alternaria* and *Stemphylium.* Recently, Vasudeva (1962) reported *A. tenuissima* from India but did not indicate the host. In this note, *Chrysanthemum cinerariæfolium* Vis., Pyrethrum, is described as a new host for *A. tenuissima* (Fr.) Wiltsh. which is evidently a first record of *Alternaria* blight on Pyrethrum.

A strain of *Chrysanthemum cinerariæfolium* introduced from Soviet Russia by Dr. M. N. Ramaswamy is under cultivation in the Central Indian Medicinal Plants Organisation's Experimental Farm at Devanahalli near Bangalore. During October 1964, when the plants were about 6 months old, brown patches, 2–4 mm. in diameter, were observed near the apical part of the leaves. These patches enlarged irregularly, turning blackish-brown in colour. Eventually the necrosis covered the entire leaf area and proved fatal to the plant. Affected portions were examined and the fungus was identified as *Alternaria tenuissima* (Fr.) Wiltshire. The following is the description of the local isolate.

Conidiophores dark brown, septate, septa 8–10 μ apart, sub-erect to erect, unbranched, measuring 30–110 × 3–4 μ. Conidia dilute brown produced in short chains of 2–4, acrogenous, smooth, obclavate, 30–40 × 11–19 μ, with 3–9 transverse and 2–4 longitudinal septa; smooth-walled, beak 7–14 × 1–2 μ with an obtuse end. Further investigations on its pathogenicity and cultural characters are in progress. The specimens have been deposited in the Commonwealth Mycological Institute, Kew (I.M.I. 109481) and in CIMPO, Herb., Bang., No. 122.
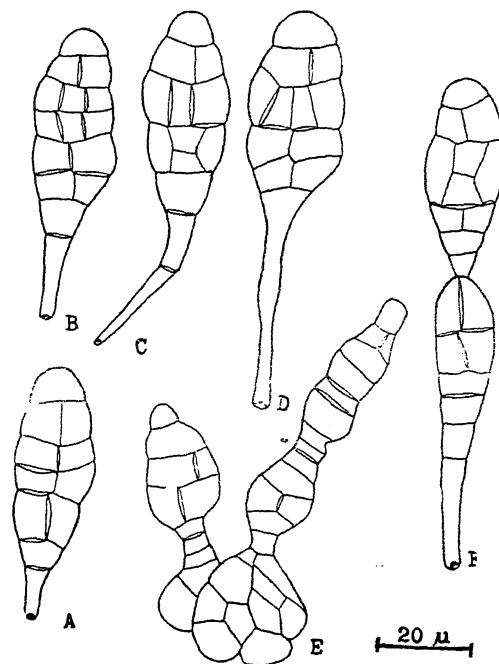
FIG. 1. A–D. Conidia, E and F. Conidia in chains.

Grateful thanks are due to Dr. M. B. Ellis of Commonwealth Mycological Institute, Kew, England, for confirming the identification of the fungus and Dr. M. N. Ramaswamy, CIMPO, Bangalore, for his personal interest and encouragement.

CIMPO, Bangalore,   K. V. SRINATH.
February 20, 1965.   M. SARWAR.

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REVIEWS AND NOTICES OF BOOKS

Generalized Functions, Vol. 1. *Properties and Operations.* By I. M. Gel'fand and G. E. Shilov. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xviii + 423. Price $ 12.00.

This is the first volume in a series of five volumes dealing with generalized functions. In this volume, continuous linear functionals on various classes of test functions are defined as generalized functions, which are called distributions if the test functions have compact support. Among the topics covered are differentiation and integration of generalized functions, local properties, convolutions, Fourier transforms, generalized functions depending analytically on a parameter, and applications to differential equations. Many particular types of generalized functions are discussed and calculated. The book contains tables of generalized functions and Fourier transforms, and includes the appendix to the fifth volume of the Russian edition, discussing generalized functions of one and several complex variables.   C. V. R.

The Physiology of Insecta, Vol. 1. Edited by Morris Rockstein. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xiv + 640. Price $ 22.00 Regular Price and $ 19.50 Subscription Price.

This is the first volume of a series intended to bring together the known facts and material, and to discuss the unsettled problems of insect physiology. The volume has been organized into three main sections, *viz.,* the ontogeny of insects from reproduction to senescence of the individual, the insect's perception of and reaction to its external environment and the mechanisms by which the internal homeostatic state is maintained.

The present volume contains thirteen chapters. Part A which deals with the Biology, Development, and Aging contains the following chapters : 1. Biology of the Insecta, by Morris Rockstein ; 2. Reproduction, by Jan De Wilde ; 3. Reproduction—Endocrine Control, by Jan De Wilde ; 4. Physiological and Biochemical Changes during Insect Development, by Ivar Agrell ; 5. Physiology of Growth and Development : Endocrine Aspects, by Lawrence I. Gilbert ; 6. Aging in Insects, by Arnold M. Clark and Morris Rockstein.   Part B

which deals with the Insect and the External Environment-I, contains the following chapters : 1. Environmental Aspects : Temperature, by E. Bursell ; 2. Environmental Aspects : Humidity, by E. Bursell ; 3. Chemoreception, by E. S. Hodgson ; 4. The Visual System of Insects, by Timothy H. Goldsmith ; 5. Insect Bioluminescence, by W. D. McElroy ; 6. Mechanoreception, by J. Schwartzkopff and 7. Sound Production, by P. T. Haskell.   C. V. R.

Advances in Inorganic Chemistry and Radiochemistry, Vol. 5. Edited by H. J. Emeleus and A. G. Sharpe. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. ix + 429. Price $ 14.50.

Volume 5 of this well-known series contains the following articles : (*i*) The Stabilization of Oxidation States of the Transition Metals, by R. S. Nyholm and M. L. Tobe ; (*ii*) Oxides and Oxyfluorides of the Halogens, by M. Schmeisser and K. Brandle ; (*iii*) The Chemistry of Gallium, by N. N. Greenwood ; (*iv*) Chemical Effects of Nuclear Activation in Gases and Liquids, by I. G. Campbell ; (*v*) Gaseous Hydroxides, by O. Glemser and H. G. Wendlandt ; (*vi*) The Borazines, by E. K. Mellon, Jr., and J. J. Lagowski ; (*vii*) Decaborane-14 and its Derivatives, by M. Frederick Hawthorne and (*viii*) The Structure and Reactivity of Organophosphorous Compounds, by R. F. Hudson.

Each article, as usual, is followed by an extensive bibliography.   C. V. R.

Advances in Protein Chemistry, Vol. 18. Edited by C. B. Anfinsen, M. L. Anson and J. T. Edsall. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. x + 335. Price $ 14.00.

The present volume of this well-known series contains the undermentioned articles : (*i*) Recent Studies on the Structure of Tobacco Mosaic Virus, by F. Alred Anderer ; (*ii*) Assembly and Stability of the Tobacco Mosaic Virus Particle, by D. L. D. Caspar ; (*iii*) The Dissociation and Association of Protein Structures, by F. J. Reithel and (*iv*) The Amino-Acid Composition of Some Purified Proteins, by G. R. Tristram and R. H. Smith. The first, second and third articles contain extensive bibliographies covering some

twenty pages in all. The last article includes no less than 23 tables giving the amino-acid composition of proteins from numerous sources, besides an extensive bibliography.   C. V. R.

Analytical Methods for Pesticides, Plant Growth Regulations, and Food Additives. (Academic Press, New York and London).

Volume II : *Insecticides.* Edited by Gunter Zweig, 1964. Pp. xvii + 619. Price $ 20.00 Subscription and $ 23.00 Regular.

This volume presents detailed insecticidal procedures as well as the history, biological and chemical properties, and physical constants of 47 widely used insecticides. The term insecticides includes miticides, acaricides, etc.

Among the topics covered in this comprehensive work are two methods of analysis of Thiodan by gas-liquid chromatography, and the problem of finding a specific method for final identification of residues.

This second volume, like its predecessor, will provide research chemists interested in the analysis of these chemicals with a single information source on the subject.

Volume III : *Fungicides, Nematocides and Soil Fumigants, Rodenticides, and Food and Feed Additives.* Edited by Gunter Zweig, 1964. Pp. xii + 237. Price $ 12.00 Regular and $ 10.00 Subscription.

This volume deals with formulation and residue analytical procedures of widely used fungicides, fumigants, rodenticides, food, and feed additives. Analytical data as well as information on the chemical and biological properties of these compounds are given. For three fungicides alternate analytical methods used in different laboratories are described.

Volume IV : *Herbicides.* Edited by Gunter Zweig, 1964. Pp. xiii + 269. Price $ 10.00 Subscription and $ 12.00 Regular.

In Volume IV of this treatise different herbicides and plant growth regulators which at present are widely used are covered in detail. Experimental methods for formulation and residue analyses have been described by experts or originators of the methods. Where an analytical method is recommended for several herbicides, the chapters have been combined, for example, Chapter 16 covering monuron, diuron, and neburon.

Again, as in Volumes II and III of this treatise, other valuable data for each compound are included, such as chemical and biological properties, history of development, methods of synthesis, and modified residue methods for different crops.   C. V. R.

Mineral Metabolism (*An Advanced Treatise*), Vol. 2,. Part A, *The Elements.* Edited by C. L. Comar and Felix Bronner. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 649. Price $ 22.00.

Volume I, Parts A and B, of this treatise were reviewed in *Current Science* of February 1963 and Volume 2, Part B of this treatise has already been reviewed in *Current Science* of May 1963.

Volume 2, Part A, contains eight chapters, 17–24. Chapter 17 is a most valuable and comprehensive monograph by Elsie M. Widdowson and J. W. T. Dickerson on Chemical Composition of the Body, extending over to 207 pages. The other chapters are shorter and deal respectively with the particular elements/topics as listed below : Chapter 18 on Dynamics and Function of Phosphorus, by James T. Irving ; Chapter 19 on Disturbances of Phosphorus Metabolism, by Frederic C. Bartter ; Chapter 20 on Dynamics and Function of Calcium, by Felix Bronner ; Chapter 21 on Disturbances of Calcium Metabolism, by William C. Thomas, Nr., and John Eager Howard ; Chapter 22 on Magnesium, by Warren E. C. Wacker and Bert L. Vallee ; Chapter 23 on Strontium, by C. L. Comar and R. H. Wasserman ; Chapter 24 on Fluoride, by Harold C. Hodge.   C. V. R.

Electron Microscopic Anatomy. Edited by Stanley M. Kurtz. (Academic Press, New York and London), 1964. Pp. xii + 425. Price $ 14.00.

This sumptuously illustrated volume consists of fourteen chapters which are arranged as a series of monographs of which the first discusses the general aspects of tissue fine structure and explains the terminology to be encountered in the following chapters. The illustrations appearing in the volume were made from epoxy- or polyester-embedded specimens so that images of the highest quality could be presented. The successive chapters in the volume are as follows : 1. Liver ; 2. The Pancreas ; 3. The Salivary Glands ; 4. Stomach and Intestinal Mucosa ; 5. Hemopoietic Tissue and Blood ; 6. Lymphoid Tissue ; 7 Endocrine Organs : The Adrenal Gland ; 8. Thyroid Gland ; 9. The Kidney ; 10. Skeletal, Cardiac, and Smooth Muscle ; 11. Cartilage ; 12. Bone ; 13. Peripheral

Nervous Tissue and 14. Tissue of the Central Nervous System.

This text will be a useful reference for everyone interested in the fine structure of mammalian tissues and for those directly engaged in electron microscopy.　　　　　　　　　　C. V. R.

Advances in Applied Mechanics. (Volume 6, Vol. 7, Vol. 8). Edited by H. L. Dryden and Th. von Karman, Managing Editor G. Kuerti. (Academic Press, New York and London).
Volume 6, 1960. Pp. 294. Price $9.00.
Volume 7, 1962. Pp. 327. Price $11.00.
Volume 8, 1964. Pp. 298. Price $12.00.

The sixth volume of *Advances in Applied Mechanics* contains the following articles: 1. The Theory of Unsteady Laminar Boundary Layers, by K. Stewartson; 2. Boundary-Layer Theory with Dissociation and Ionization, by G. Ludwig and M. Heil; 3. The Propagation of Shock Waves along Ducts of Varying Cross-section, by W. Chester; 4. Similarity and Equivalence in Compressible Flow, by Klaus Oswatitsch and 5. Karman Vortex Streets, by R. Wille.

The seventh volume of *Advances in Applied Mechanics* contains the following articles: 1. Hypersonic Flow over Slender Bodies Associated with Power-Law Shocks, by Harold Mirels; 2. The Mathematical Theory of Equilibrium Cracks in Brittle Fracture, by G. I. Barenblatt; 3. Plasticity under Non-Homogeneous Conditions, by W. Olszak, J. Rychlewski and W. Urbanowski; and 4. Some Elementary Problems in Magneto-hydrodynamics, by Raymond Hide and Paul H. Roberts.

The eighth volume of *Advances in Applied Mechanics* contains the following articles: 1. Magneto-Aerodynamic Flow Past Bodies, by W. R. Sears and E. L. Resler, Jr.; 2. Incompressible Second-Order Fluids, by Hershed Markovitz and Bernard D. Colemen; 3. The Generation of Sound by Turbulent Jets, by H. S. Ribner; 4. Stability of Motion of Solid Bodies with Liquid-Filled Cavities by Lyapunov's Methods, by V. V. Rumyantzev; and 5. Introduction to the Theory of Oscillations of Liquid-containing Bodies, by N. N. Moiseev.
　　　　　　　　　　　　　　　C. V. R.

Fuel Cells. Edited by Will Mitchell, Jr., (Academic Press, New York and London), 1963. Pp. xv + 442. Price $15.00.

This monograph presents current developments in fuel cell technology in the United States and Europe. Fifteen authorities have contributed sections which cover both theoretical and applied concepts as well as research and engineering problems recognized in current fuel cell technology. The authors have included specific data much of which has previously been considered proprietary. The book provides the investigator with sufficient background to permit him to initiate a sound research and development program in the broad field of fuel cell art. An extended bibliography at the end of each chapter makes the volume invaluable to all researchers in fuel cells.　　　　　　　　C. V. R.

Cosmic Radiations and High Energy Interactions. By V. D. Hopper. (Academic Press, Inc., Berkeley Square House, Berkeley Square, London W. 1), 1964. Pp. x + 234. Price 57 *sh.* 6 *d.*

The main purpose of this book is to emphasize the fundamental features involved in the experimental study of cosmic radiation. It provides a much needed survey in detail of this important subject, and will enable its rapidly growing literature to be read with appreciation and understanding. In addition, research workers in this field no longer need to have all the most expensive facilities at their disposal: new experimental techniques have recently been developed which enable those in laboratories with limited financial resources to make important contributions. The results of measurements obtained by these new techniques are discussed.　　　　　　C. V. R.

The Lunar Surface Layer: Materials and Characteristics. Edited by John W. Salisbury and Peter E. Glaser. (Academic Press, New York and London), 1964. Pp. xxvi + 532. Price $12.00.

This book, to which outstanding workers in the field have contributed, is a unique presentation of current thought on the nature of the lunar surface. The scope of the work is unusually broad, and deals with both scientific and practical problems. This twofold approach to the subject makes this book invaluable for both scientists concerned with the nature and origin of lunar surface and engineers concerned with the design and construction of lunar landing or roving vehicles.

The subject-matter includes soil mechanics, factors affecting soil cohesion, sonic velocity in materials, the effects of micro-meteoroid bombardment and meteoroid impact, electrodynamic effects, sputtering effects, photometric

and thermal emission studies, evidence of the structure and processes occurring on the lunar surface, thermal and mechanical properties, lunar surface characteristics, effects of surface roughness, and possible soil stabilization techniques. C. V. R.

Fundamental Topics in Relativistic Fluid Mechanics and Magnetohydrodynamics. Edited by Robert Wasserman and Charles P. Wells. (Academic Press, New York and London), 1963. Pp. 241. Price $ 8.50.

The work under review represents the proceedings of a symposium held at Michigan State University on October 10-11, 1962 and consists of eight invited addresses and five contributed papers:

Invited Addresses: Absence of a Gravitational Analog to Electrical Charge, by John A. Wheeler; Hydrodynamics and General Relativity, by A. H. Taub; Invariance Groups, by Peter Bergbann; The Cauchy Problem and Entropy in Charged Compressible Relativistic Self-inductive Fluids, by N. Coburn; Singular Properties of Flow Pattern at Small Magnetic Reynolds Numbers, by G. S. S. Ludford; Stability of Magnetofluid Free Boundaries against Finite Perturbation, by A. A. Blank; Generalization of Topological Aspects in Existence Proofs to Magnetohydrodynamics, by M. Z. Krzywoblocki; Magnetohydrodynamic Wave Propagation in a Dipole Field, by John Carstoiu.

As is clear from the titles the primary aim of the symposium was to discuss the theoretical aspects of the subject and consequently no attention has been given to applications.

The contributed papers are on varied topics but once again each paper makes a valuable contribution to the topic under discussion.

The book is a valuable addition to a very small list of books on the subject of Relativistic Fluid Mechanics and Magnetohydrodynamics.

P. L. Bhatnagar.

Advances in Agronomy, Vol. 16. Edited by A. G. Norman. (Academic Press, Inc., 111, Fifth Avenue, New York, New York-10003), 1964. Pp. 414. Price $ 13.50.

Eighteen authors have contributed to the critical surveys presented in this volume on the following nine topics: 1. Available Phosphorus in Fertilizers; 2. Field Plant Physiology; 3. Objectives in Corn Improvements; 4. Salinity in Relation to Irrigation; 5. Plant Response to Soil Compaction; 6. Nitrate Accumulation and Poisoning; 7. Characterizing Soil Oxygen Conditions; 8. Population Variability and Plant Breeding; and 9. Amorphous Inorganic Materials in Soils.

It will be noticed that problems connected with soil and its productive use occupy a major share in the volume. This emphasis should be welcomed by agronomists especially against the present background of several countries of the world embarking on ambitious land development projects to meet the growing crisis in food production against population increase.

In the article on "Available" phosphorus in fertilizers, the authors discuss the effects of various fertilizer characteristics on crop response to phosphorus in applied fertilizers, with emphasis on chemical composition and dissolution in water and ammonium citrate solution. Recent findings on the relationship of particular environmetal factors to the growth and development of the plant are discussed in the chapter on Field Plant Physiology.

Salinity is an everpresent threat to the permanence of irrigation agriculture, and requires careful controlling lest the consequent diminishing productivity should ultimately lead to the land being abandoned for cultivation. The author of this chapter discusses the technical aspects of the problems of irrigation agriculture on salt-affected land.

The chapter on Plant Breeding and Population Variability is specially interesting as this is perhaps the first exposition of computer techniques being used in agronomical research.

A. S. G.

Celestial Mechanics and Astrodynamics. Edited by Victor G. Szebehely. (Academic Press, Inc., 111, Fifth Avenue, New York-10003), 1964. Pp. 744. Price $ 10.75.

This publication is Volume 14 of the series Progress in Astronautics and Aeronautics, and contains a selection of technical papers based on the Conference on Astrodynamics held at New Haven, Connecticut in August 19 to 21, 1963, under the auspices of the American Institute of Aeronautics and Astronautics.

An important feature of this collection is that it combines the astronomical and the engineering approaches to orbits and trajectory problems in space research, as the following titles of the six divisions into which the book is divided will show: I. Orbit Prediction and General Perturbations; II. Astronomical Constants and Physical

Properties; III. Orbit Selection; IV. Orbit Mechanics of the Ranger and Mariner Missions; V. Orbit Transfer Trajectory Optimization; VI. Orbit Determination.

The book is essentially intended for the worker in the field of space research with background knowledge in celestial mechanics and also familiarity with the engineering problems involved. A. S. G.

Documents on Modern Physics—*Motion of Charged Particles in the Earth's Magnetic Field*. By J. W. Chamberlain. (Gordon and Breach Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. 32. Price Paper bound $ 1.95 ; Cloth bound $ 3.95.

This booklet belongs to the series *Documents on Modern Physics* a new venture undertaken by the Publishers Gordon and Breach with the specific aim of providing specialist workers in a particular branch of physics of current interest with the latest developments in the subject with sufficient background material and references. To this end, lectures, conference proceedings and reviews on the subject concerned are selected and edited as *Documents* and made available at low price.

The present publication contains the lectures on the subject of the title delivered by the author at the Las Houches Summer School of Theoretical Physics and published in the proceedings volume, *Geophysics, the Earth's Environment*, which was earlier reviewed in these columns.—(see *Curr. Sci.*, 1964, 33, 444) A. S. G.

Refractory Transition Metal Compounds: High Temperature Cermets. By G. V. Samsonov. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. viii + 220. Price $ 9.00.

Refractory compounds of transition metals with carbon, nitrogen, boron and silicon form a group of important new engineering materials which combine a number of physical properties characteristic of metals as well as non-metals. Thus they have high melting points, unique electrical and magnetic properties, high hardness, metallic lustre, and chemical stability. The study of these substances is of great interest both in applied science and in the general theory of solids.

This book contains a collection of about 20 papers on studies of refractory compounds of transition metals carried out in recent years in the various technological research institutes in Russia and many of them presented at Seminars on the subject. The book will acquaint the technical workers concerned on the progress and latest achievements in this field of study and on the methods for the systematic investigation and classification of these important compounds. A. S. G.

Books Received

Analysis Instrumentation. Edited by L. Fowler, R. J. Harmon and D. K. Roe. (Plenum Press, New York), 1964. Pp. x + 340. Price $ 14.50.

Interpreted Infra-red Spectra (Vol. I). By H. A. Szymanski. (Plenum Press, New York), 1964. Pp. 293. Price $ 10.75.

Handbook of Analytical Design for Wear. Edited by C. M. Macgregor. (Plenum Press, New York), 1964. Pp. 97. Price $ 12.50.

Chemistry of Lac. By P. K. Bose, Y. Sankaranarayanan and S. C. Sen Gupta. (Indian Lac Research Institute, P.O. Namkum, Ranchi, Bihar), 1963. Pp. viii + 225. Price Rs. 20·40.

Mathematical Theory of Probability and Statistics. By R. Von Mises. Edited and Complimented by Hilda Geiringer. (Academic Press, Inc., New York, N.Y.), 1964. Pp. xiv + 694. Price $ 22.00.

Generalized Functions (Vol. 4)—*Applications of Harmonic Analysis.* By I. M. Gel'Fand and N. Ya Vilenkin, Translated by Amiel Feinstein. (Academic Press, Inc., New York), 1964. Pp. xiv + 384. Price $ 11.50.

Advances in Applied Microbiology (Vol. 6). Edited by W. W. Umbreit. (Academic Press, New York), 1964. Pp. xi + 259. Price $ 10.00.

Introduction to the Mechanics of a Continuous Medium. By L. I. Sedov. (Addison-Wesley Publishing Co., Reading, Mass.), 1964. Pp. xvi + 270. Price $ 12.50.

Physical Geochemistry. By F. Gordonsimth. (Addison-Wesley Publishing Co., Reading, Mass.), 1965. Pp. x + 624. Price $ 15.00.

Introduction to Semiconductor Devices. By M. J. Morant. (Addison-Wesley Publishing Co., Reading, Mass.), 1964. Pp. 126. Price $ 2.95.

Progress in Infra-red Spectroscopy (Vol. 2). Edited by H. A. Szymanski. (Plenum Press, New York), 1964. Pp. 298. Price $ 12.50.

SCIENCE NOTES AND NEWS

Award of Research Degree

The University of Poona has awarded the Ph.D. degree in Botany to Shri Sudhanshu Kumar Jain for his thesis entitled "Studies on the Vegetation of Arid, Semi-Arid and Some Adjacent Regions of Western India".

Bauchite : A New Variety in the Quartz Monzonitic Series

A coarse plutonic fayalite-bearing rock has been found to be fairly widespread in Nigeria. Around the town Bauchi in Northern Nigeria a single occurrence covers about 20 square miles. Because of its peculiar characteristics which are not adequately conveyed by the general or group name, M. O. Oyawoye, who has described it has proposed the name "bauchite".

The name bauchite is used to denote a dark greenish fayalite-bearing rock of quartz syenite to adamellite mineralogical composition which was first described from Bauchi. Its salient and diagnostic characteristics are : (1) The feldspar of the rock, a microperthite, is dark green in colour and the quartz is brownish-green with resinous lustre. (2) Fayalite occurs in association with amphibole and is commonly arranged in zones. The amphibole is commonly moulded around the plagioclase and the fayalite is usually in a quartz matrix. (3) The rock occurs in plutonic setting commonly fringed by charnockite and surrounded by a plutonic granite.

Oyawoye is of the view that the bauchite originated by an emanation into granite of ferrous iron-rich fluid or magma. The green colour of charnockite and bauchite is believed to be due to impregnation of feldspars with ferrous iron during the emanation—(*Nature*, 1965, 205, 689.)

Two-Particle Theory of Matter

Dr. E. J. Sternglass of Westinghouse Research Laboratories has reported new evidence in support of his electron-positron theory of matter. The essence of the theory is that matter is built up of pairs of electrons and positrons arranged in closely spaced orbits, in which they move together at nearly the speed of light. In a technical paper (*Physical Review*, 1961, 123, 391) Sternglass analyzed the simplest possible grouping, *viz.*, one electron and one positron rotating in an orbit some 100,000 times smaller than the diameter of the hydrogen atom. The system was shown to exhibit the properties and behaviour of the neutral pi meson (π°).

Two years later, in 1963, this basic model was extended to include two or more electron-positron pairs rotating together, to explain the heavier neutral mesons, and resonance particles that decay into pi mesons.

New calculations reported in *Nuovo Cimento* (1965, 35, 227) extend the basic model still further to account for : (1) the masses and life-times of the mu mesons μ^+ and μ^-, and of the pi mesons π^+ and π^-, (2) the small force between the mu meson and other nuclear particles, (3) the "strong" interactions between pi mesons, and (4) the relationship of neutrino to other nuclear particles.—(*Nuovo Cimento*, 1965, 35, 227).

Plasma Diagnostics using the Raman Effect

Much of the recent research in the area of plasma physics has been aimed at determining the importance of certain plasma processes in various applications. The processes of interest include recombination rates, diffusion constants, energy transfer processes and chemical activity in the plasma. In this regard it is essential to obtain experimental data on important plasma parameters such as electron density, ion density, the individual species present and their densities and temperatures.

One technique that is receiving considerable attention is the detection and measurement of Raman effect in light scattering from a plasma. The Raman effect has been used for many years to study the internal structure of the molecules of liquids, gases and solids. The development of the laser has provided an ideal Raman source thus enlarging the application of the method to new fields of study. Now it is feasible to obtain Raman spectra in extremely short times (1 millisecond) of scattering molecules and ions from extremely small areas (1 mm.^{2}) by spot-focusing the highly directional monochromatic laser beam in the scattering medium. This has opened up new possibilities of using a laser beam as a plasma probe for diagnostic study of plasma. By measuring the relative intensities of the Stokes and anti-Stokes Raman lines a determination can be made of the density and temperature of the individual species present in a plasma.

Such a study has been undertaken in the Applied Studies Section of the Space Surveillance and Instrumentation Branch at Rome Air Development Center (RADC). In a preliminary Report to acquaint the workers in the area of plasma physics with a new and promising plasma diagnostic technique, the Study Group has presented the theory correlating the Raman intensity with the specie density and temperature, along with experimental technique and results so far achieved. (*Technical Documentary Report, RADC-64-5.*)

New Laser Material for Automatic Giant Laser Pulses

Westinghouse research scientists have produced a new laser material that automatically generates giant pulses of laser light. Ordinarily, what is known as giant-spike operation for laser emission is achieved by means of complicated optical apparatus placed outside the laser. Now, a new kind of glass laser material developed in the Westinghouse Laboratories enables such giant spikes of energy to be produced within the laser rod itself.

The giant-spike material is a modified form of neodymium glass which is itself well known for its laser action. Ordinary neodymium glass is simply a special high-quality glass to which has been added a small percentage of neodymium ions. This impurity ion is what causes the glass to lase.

In the modified neodymium glass a small amount of uranium in the form of uranyl (UO_2^{++}) ions is added. During 'pumping' both the neodymium ions and the uranyl ions absorb energy. The absorption of the uranyl ions holds back the laser action of the neodymium. This delay allows time for many more neodymium ions to be pumped to their higher energy level before the laser burst occurs.

For the burst to take place, the greater number of inverted neodymium ions finally overcomes the delaying action of the uranium. The laser fires as a giant spike of high power and short duration, with the uranyl ions acting as a sort of built in timer that turns the laser action on at just the right instant. When done externally, this delaying and releasing is known as Q-switching. In the present case the neodymium uranyl rod switches itself.—(*Westinghouse News.*)

Quasi-Stellar Radio Sources as Spherical Galaxies in the Process of Formation

The quasi-stellar radio sources are the brightest objects known. The energy radiated by the quasar 3 C 48 has been estimated as 2×10^{46} erg/sec. One therefore asks if there is a phase in the evolution of a galaxy characterized by such a luminosity. It has been pointed out that, very early in the life of a galaxy, the gas density and therefore the rate of star formation would be high. Shklovsky estimated an absolute magnitude of -23 (minus 23) due to supernovæ alone.

Following Shklovsky's suggestion, G.B. Field of the Princeton University Observatory, has studied the earliest phases in the life of a galaxy, and calculated the properties of a galaxy forming from an intergalactic gas cloud. If a cloud of 10^{11} suns is formed with sufficient angular momentum to prevent the formation of a "massive object", but too little to permit the formation of a disc, a period of vigrous star formation is expected. Rough estimates of the phase of the commencement of star formation yield radii and velocities in the vicinity of those of the quasi-stellar sources. It is found that the radiation emitted by the young stars in such a system is of the order required in the quasars.

The crucial point is the suddenness of star formation associated with the rapid rise of gas density in the contraction of a slowly rotating system.—(*Astrophys. Jour.*, 1964, 140, 1434.)

Endeavour Prizes

Imperial Chemical Industries Limited, Publishers of the International Scientific Review *Endeavour*, award prizes totalling 100 guineas for essays submitted on any one of the following subjects: (1) Physics of the Moon, (2) Physiological basis of memory, (3) Molecular sieves, (4) Chemicals from oil, (5) Mechanisms of enzyme action and (6) Strength of materials.

The competition is restricted to younger scientists, whose twenty-fifth birthday falls on or after 1st September 1965. Only one entry is permitted for each competitor. The essay, which must be in English and typewritten, should not exceed 4,000 words in length and should reach the undersigned before 1st June 1965. The Deputy Secretary, British Association for the Advancement of Sciences, 3 Sanctuary Buildings, Great Smith St., London S.W. 1.

THE NEW PHYSIOLOGY OF VISION

Chapter XVII. Location of Visual Pigments in the Retina

Sir C. V. RAMAN

WE proceed to consider the significance of the results of our studies on the chromatic responses of the retina and to view them in the light of the conclusions regarding the identity and spectroscopic behaviour of the visual pigments arrived at in earlier chapters. For this purpose, it is necessary to summarise the results of those studies. As has already been explained, what the observer notices when he views a brightly illuminated screen through a colour filter and then suddenly removes the filter depends very much on the spectral region in which the absorption by the filter is manifested and hence differs from filter to filter.

On the basis of the observed phenomena, the part of the visible spectrum in which the absorption by the filter is effective may be placed in any one of the following four divisions, viz., I. from 4000 to 5000 A.U.; II. from 5000 to 5600 A.U.; III. 5600 to 6000 A.U. and IV. from 6000 to 7000 A.U. These regions will, in what follows, be referred to as the blue, green, yellow and red sectors of the spectrum, these being the colours which are dominant respectively in these four regions. The picture of the retina as perceived by the observer following the removal of the filter may likewise be divided into three regions. A. the fovea; B. a circular area surrounding the fovea and having a well-defined margin and a diameter about four times that of the fovea; C. The surrounding field. The luminosity and colour exhibited by these regions are related to the spectral region of absorption by the filter in a clearly definable fashion. We may indeed say that the part or parts of the spectrum in which the absorption by the colour filter appears determines the picture seen of the retina in all its details.

By far the most spectacular effects are those observed with the colour filters of which the absorption completely covers the yellow sector of the spectrum. Indeed, the phenomena observed with such filters are altogether different from those observed with the filters which exhibit absorption exclusively in the blue, green or red sectors. The striking feature exhibited by them is the manifestation of the fovea as a luminous disk conspicuous by reason of its brightness which much exceeds that of the surrounding areas. Surrounding the foveal disk and of a lesser brightness, but nevertheless clearly differentiated from the outer parts of the field is a circular area having a diameter about four times greater than that of the fovea. These features are not observed when the filters employed have an absorption lying exclusively in the blue, green or red sectors.

Thus, the observations with the colour filters demonstrate that the yellow sector of the spectrum stands in a class by itself and that it plays a highly significant role in the phenomena of vision. The same conclusion has already been arrived at and stated in earlier chapters on the basis of other considerations. But the new result which now emerges is that the visual pigment which enables us to perceive light appearing in the yellow sector of the spectrum is concentrated in the foveal region of the retina and in the areas immediately surrounding it. Only on that basis is it possible to understand the facts of observation.

The distributions in the retina of the visual pigments which enable us to perceive the blue, green and red sectors of the spectrum are clearly of a different nature. This is made evident by the picture of the retina which is seen when the filter made use of has its absorption in one or another of these three sectors. The glow exhibited by the area of the retina under observation (blue, green, red in colour as the case may be) in the areas surrounding the fovea is of uniform brightness. The fovea itself presents a different appearance in the three cases. With the filters which have a cut-off in the blue, the fovea does not exhibit the blue glow but is seen as a disk with a sharply defined edge and of a pale yellow colour. Likewise, with the filters having a cut-off in the green sector of the spectrum, the fovea does not exhibit the glow seen outside of it, but is seen dimly with a bluish tinge. In the case of the filters having a cut-off in the red, the glow seen elsewhere covers the fovea as well.

Thus, a systematic survey of the retina with the aid of colour filters exhibiting absorption in

a relatively narrow range of the spectrum but which between them cover the entire visible spectrum from end to end enables us to establish the result that there are four visual pigments which function in the perception of light in ordinary or daylight vision. It also enables us to indicate the regions of the spectrum in which they respectively function and the manner in which they are distributed over the retina.

In earlier chapters, the visual pigments functioning in the yellow and green sectors of the spectrum were identified respectively as the fully oxygenated form and as the reduced form of heme. The former identification was based on some very significant facts of observation, *viz.*, that the yellow of the spectrum appears precisely at the same position as the sharply defined peak of light-absorption at 579 mμ exhibited by oxygenated heme, that a remarkably high power of colour discrimination is manifested in the vicinity of that wavelength and that the spectrum also exhibits a high luminous efficiency in that region. The observations made with the colour filters fit in perfectly with this situation. It is found, as is to be expected in these circumstances, that the retinal pictures alter in a remarkable fashion as the region of absorption by the filter moves from the red into the yellow sector of the spectrum. The foveal disk appears quite suddenly and exhibits at first a yellow hue. It then gains in luminosity and takes on a greenish-yellow colour and finally appears a brilliant green when the absorption by the filter covers the wavelength region between 600 mμ and 560 mμ and extends further into the green. But filters exhibiting absorption in the green sector alone and not extending into the yellow sector do not produce any such effects.

These experiences are readily understood when we take note of the form of the light-absorption curves of the oxygenated and of the reduced forms of heme in the wavelength range between 600 mμ and 500 mμ. Both forms of heme exhibit a powerful absorption in this range. But the oxygenated form has a sharply defined and intense absorption at 579 mμ, falling off steeply towards greater wavelengths and much less steeply towards shorter wavelengths. It also has a second weak and diffuse maximum of absorption around 542 mμ. The reduced form of heme has only a single wide-band maximum of absorption around 555 mμ and since this form of the heme pigment is not present in quantity in the region of the fovea, filters of which the absorption appears only in the region between 500 mμ and 560 mμ do not exhibit any such effects as those described above.

We may here appropriately mention the remarkable changes in the relative intensity of the yellow and green sectors of the spectrum as visually observed which accompany a progressive fall in the absolute intensity of both sectors. These effects may be conveniently observed in the following fashion. The light emerging from a bulb containing luminous mercury vapour is examined through a pocket spectroscope with the slit opened rather wide. The green and yellow lines of the mercury arc spectrum then appear as patches of light side by side exhibiting these colours. A progressive reduction of their absolute luminosities may be readily obtained by interposing a sheet of opal glass between the lamp and the spectroscope and by the observer moving away from the lamp together with the opal glass sheet and the spectroscope. When he is close to the lamp, the green and yellow patches appear of comparable brightness. But when he is at the other end of the room, both the green and yellow patches exhibit their respective colours, but the yellow appears much less bright than the green. When a further reduction of intensity is produced by the introduction of additional diffusing screens, *e.g.*, sheets of white paper, the yellow becomes progressively feebler and in the limit extremely weak relatively to the green, while the latter continues to be readily observable.

The phenomenon described above is obviously complementary to the enormously enhanced brightness of the yellow region in the spectrum observed at high levels of luminosity and described in detail in an earlier chapter. In other words, the observed fall in luminosity of the yellow relatively to the green at low levels of brightness is a part of the same sequence of changes in the visual luminosity of the yellow sector as that produced by increases in its absolute level of brightness. That this is actually the case may be demonstrated using the same techniques as those employed earlier for observations of the yellow sensation at high levels of luminosity. The spectrum of a straight tungsten filament heated by an electric current is viewed by the observer from an appropriate distance holding a replica grating before his eye. As the heating current is pro-

gressively diminished, it will be noted that the brightness of the yellow sector in the spectrum relatively to the green and the red sectors on its two sides falls off, until it becomes barely recognisable.

The presence of the oxidised form of the heme pigment in notable quantities in the region of the fovea and in a circular area surrounding that region finds a ready explanation if it be assumed that the pigment enters the retina as an exudate from the highly vascular choroid coat immediately behind it. After entering the foveal pit which is the thinnest part of the retina, it would spread symmetrically outwards from it into the surrounding region. If, further, it be assumed that the quantity of the pigment thus made available for vision varies with the demand for it, in other words, on the level of luminosity at which the retina is functioning, the preponderance of the yellow sensation at high levels of luminosity, and its relative weakness or even total absence at low levels of brightness would find a ready explanation. Since the luminous efficiency of the spectrum in the wavelength range from 600 mμ to 500 mμ is determined jointly by the oxidised and reduced forms of heme, the relative proportion in which these are present would influence the spectral distribution of luminosity in this range of wavelengths. If the oxidised form is present in preponderating measure, the yellow sector would be much more luminous than the green. If it is absent or deficient, the green sector would be far more luminous than the yellow.

The presence of the heme pigment in its fully oxidised form in the retina may be expected to involve as a natural consequence its being accompanied by the same pigment in its ordinary or reduced form. The latter pigment exhibits a wide-band absorption maximum located at 555 mμ which is the same wavelength as that at which the luminous efficiency in the spectrum at normal levels of illumination as reported by various observers is a maximum. Thus, the identification of the reduced form of heme as one of the major visual pigments is, apart from all other considerations, fully justified by the actual facts of vision.

The presence in or behind the retina of a biochemical mechanism by which the oxygenated heme pigment in the ferrous state is transformed by auto-oxidation to the ferric form of the pigment would provide the visual pigment needed for the red sector of the spectrum. The identification of the ferric form of heme as that functioning in the spectral range between 600 mμ and 700 mμ is confirmed by the fact that it exhibits a peak of absorption at 630 mμ beyond which the absorption falls off rapidly. This is just what is needed to explain the rapid change of colour from orange to red which appears at 630 mμ, beyond which the change of colour becomes extremely slow. Further, the spectroscopic behaviour of the ferric form of heme is precisely that needed to account for the observed features of the Purkinje phenomenon which have been fully described and discussed in an earlier chapter.

CONFERENCES ON NUCLEAR MAGNETIC RESONANCE

R. VIJAYARAGHAVAN

(Tata Institute of Fundamental Research, Bombay)

TWO Conferences were held on nuclear magnetic resonance in Europe during September and October, 1964. The first one was the International Conference on NMR and relaxation in solids, organised by the "Colloque Ampere" group at the University of Leuven, Belgium, between 1–5 September, 1964. Nearly two hundred scientists from all over the world attended the Conference. The second one organised by the Italian Physical Society for the Advancement of Science, was held at the Universities of Cagliari and Sassari, Sardinia, between 28th September and 5th October, 1964.

This Conference, attended by well over hundred scientists, was mainly devoted to the application of NMR in chemistry. Among the distinguished scientists was Professor Felix Bloch, Nobel-Laureate, who, having first detected the NMR signals, was, appropriately, present to commemorate the fifteenth year of the discovery of the chemical shifts in nuclear magnetic resonance. It was in his laboratory that Arnold, Dharmatti and Packard observed the very small and extremely significant chemical shifts of proton in ethyl alcohol which were readily identified to the three groups of protons

in that organic compound. This opened up the entire field of high resolution radiofrequency spectroscopy, a finger-print of organic molecules and a powerful tool in the hands of an organic chemist.

At the Colloque Ampere, Professors Knight, Slichter, Jaccarino, Hahn, Benedek (U.S.A.), Solomon (France), and Lösche (Germany) gave review talks on various aspects of NMR in solids thereby covering the entire field. Professor Knight spoke on the experiments in superconductors with particular reference to resonance shifts, spin-lattice relaxation times, the effects of small particles, impurities and superimposed layers of different metals. The phenomenon of magnetic resonance in rotating frame was explained by Prof. Slichter in great detail. This topic dominated the best part of the proceedings. In this frame the effective magnetic field is static and the dipolar interaction between two nuclei is supposed to take place in this static field. This approach simplifies the problem in solids and is equally applicable in double resonance studies, as was shown by Prof. Hahn. The other subject on which a large number of papers were presented was the knight shifts in metals. Professor Jaccarino specifically dealt with NMR and relaxation in transition metals. He attributed the difference in electronic properties between transition and non-transition metals to the narrow unfilled d-band at the fermi surface with a large density of states and correlated the specific heat and susceptibility with NMR data in transition metals. From his analysis, it became evident that the NMR results would offer important clues to the details of the complex band structure in transition metals and alloys. Prof. Benedek (U.S.A.) explained the significance of studying NMR in solids under high pressure which changes both the hyperfine coupling and the exchange constants in ferro and ferri magnets.

Information on conduction electrons in semiconductors have been usually obtained by studying conductivity, Hall effects, etc. Surprisingly magnetic resonance has been used very little to understand the nature of conduction electrons in semiconductors. Professor Solomon showed, how, in some cases, magnetic resonance can yield valuable information on the nature of wave function of those electrons, which would often be very difficult to obtain otherwise. Professor Lösche analysed the shifts obtained in semiconductors and showed that their origin

could be either quadrupolar, chemical, or of hyperfine interaction.

The contributed papers, apart from knight shift studies, primarily dealt with the analysis of the molecular and crystal structures using the linewidth, lineshapes and shifts in nuclear magnetic resonance. Dr. Drain stressed the importance of purity in vanadium and showed that large changes in amplitude and shape could result from an impurity of one part in thousand. Professor Itoh (Japan) observed negative shifts for Cu^{63} resonance in Cu-Ni, Cu-Pd and Cu-Pt alloys. The possible origin for this shift could be a negative polarisation of copper s-band electrons at copper sites, induced by the moments of the nearest neighbour magnetic atoms.

The Sardinia Conference was mainly directed to attract chemists who have greatly profited from the discovery of N.M.R. phenomenon. The high resolution papers, naturally, dominated the discussion throughout, although one session was devoted to wide line papers. The Varian Associates (U.S.A.) described their superconducting magnets which give magnetic field of about 45 kilogauss. The spectra of protons and B^{11} at 200 and 60 mc. respectively showed the great usefulness of the cryomagnets in high resolution spectroscopy. Professor Dailey (U.S.A.) gave a new method to correlate the chemical shifts and the magnetic anisotropy in aromatic hydrocarbons. It can be shown theoretically that the chemical shifts due to the aromatic ring currents are directly proportional to the anisotropy in magnetic susceptibility. Dailey suggested that improved calculations based on "self-consistent field molecular orbital theory" should give better results and illustrated it with the examples of benzene and azulene.

Professor Buckingham (U.K.) mentioned that, in transition metal hydrides, the large chemical shifts of protons could be understood in terms of a theory in which the contributions of the metal d-electrons to the proton shielding are taken into account. C^{13} chemical shifts are very important in the determination of chemical structure but are difficult to observe owing to the poor abundance of C^{13} (1%), low gyromagnetic ratio and unfavourable relaxation times. This difficulty can be overcome if one can indirectly monitor C^{13} transitions by observing proton signals which are coupled to carbon. Dr. W. Anderson (U.S.A.) described a novel method for observing the chemical shifts of C^{13}. A modulated radiofrequency field is applied near the C^{13} resonance frequency causing the

spins to nutate at the modulation frequency. A spin-spin coupling transmits this modulation to any proton in the molecule coupled to C^{13}. Effectively it represents a small magnetic field modulation at such proton sites, and shifts proton lines accordingly. This method has been used to identify C^{13} shifts in some organic liquids.

The Tata Institute of Fundamental Research (India) presented a paper which illustrated the effectiveness of using deuteron as a probe into the nature of molecular structure and chemical bonding. Replacing proton by a deuteron does not change a compound chemically. However, proton resonance is sensitive purely to magnetic perturbations while deuteron resonance, apart from magnetic perturbation, is very susceptible to even slight changes in charge distribution. Other papers in this Conference mainly dealt with the technique of analysis of the high resolution N.M.R. spectra and its usefulness in the identification and complex structure of organic molecules.

In conclusion, the two Conferences brought out some selected topics by specialists in the field of nuclear magnetic resonance. They were extremely profitable to young scientists by offering them an incentive and opportunity to discuss a variety of recent problems with experts in this field.

PHYSIOLOGIC SPECIALIZATION OF *PIRICULARIA ORYZAE* CAV. THE CAUSAL ORGANISM OF BLAST DISEASE OF RICE

S. Y. PADMANABHAN

Central Rice Research Institute, Cuttack-6, India

BLAST disease of rice, caused by *Piricularia oryzæ* Cav. is the most serious disease of rice, wherever rice is cultivated. Prevention of loss caused by the disease through the cultivation of resistant varieties is the most hopeful and economic method. When rice varieties which had been selected as resistant to the disease at Cuttack[1,2] were sent to the State Research Centres under a co-ordinated programme for a trial of their performance under local conditions, many of them (except S. 67, BJ–1 and AC-2489 which were consistently resistant) behaved as resistant at some centres and susceptible at others.

This differential reaction exhibited by some varieties might be due to the interaction of environmental factors with the expression of disease resistance or due to the phenomenon of physiologic specialization in *Piricularia oryzæ*[3-6] with the varieties being susceptible to some races of the pathogen, while behaving as resistant to others. This could only be found out by undertaking artificial infection tests under standard set of conditions with the isolates of the pathogen obtained from different regions of India.

Such a study has been undertaken at the Central Rice Research Institute, since 1961 (under a grant received from the United States Department of Agriculture from PL-480 funds). The principal object of the study was to deter-mine whether *Piricularia oryzæ* exists as specialised races of the pathogen in India and if so, to determine the number and distribution of such races in the country.

Samples of diseased leaf necks and nodes of infected rice were collected from the principal rice-growing regions of India, mostly through the courtesy of departmental officials in each State and also by personal collection during tours.

The varieties used for the tests included the differentials which had been selected for this purpose in U.S.A. and Japan and also some more varieties which had shown marked differential reaction in co-ordinated varietal susceptibility trials in India and in an International blast varietal programme, organised during 1957-59 by the writer.[7] The varieties used in the tests are listed in Table I.

Standard procedures were adopted for raising seedlings, infecting them, for scoring of infection and classifying the varieties. By the end of 1962 four distinct races could be distinguished, one each in the Eastern, Southern, Western and Northern rice zones. Several more races have been identified in India since then. The results are presented in detail elsewhere.

The reaction of four typical Indian races differentiated on U.S. differentials are presented in Table II. The first isolate corresponds to race 8 of the U.S.A. and the last to race 25.

TABLE I

U.S. differentials	Japanese differentials	Differentials selected by the writer
Zenith	.. Ishikare Shiroke	BJ.-1
C.I. 8970 (P)	.. Homare Nishiki	AC-1613
C.I. 8970 (S)	.. Norin. **20**	S. 67
P.I. 201902	.. Norin. **22**	SM. 6
P.I. 180061	.. Kanto. 51	AC--1423
Calaro (1561-1)	.. Aichi-Asahi	AC--1443
Lacrosse (C,I. 8985)	Ginga	CR. 906
C.I. 5309	.. Chokoto	CR. 907
Wag Wag	.. Tadukan	Co. 13
Raminad Str. **3**	.. Usen	Mas
	Yakeiko	Bengawan
	Rei-Shi-ko	Intan
	Tetep	

The tests have to be rigidly standardised, if comparable results are to be obtained, not only with reference to the isolation, purification and artificial infection but also with regard to the seed used, and the method and conditions under which seedlings are raised for artificial infection as the reaction of rice to blast varies a great deal with Nitrogen nutrition and its interaction with the temperature of growth and age of the host.[8-11]

TABLE II

		Zenith	Lacrose	Caloro	C.I. 8970 (S)	C.I. 8970 (P)	C.I. 5309	P.I. 180061	P.I. 201902	Wag Wag	Raminad Str. 3	Corresponding U.S. race
Cuttack	..	R	S	S	S	S	S	S	R	R	M	8
M₄ (Madras)	..	R	M	M	M	M	S	S	S	M	R	..
Kanpur (U.P.)	..	R	S	S	S	S	S	S	R	R	S	
Gujerat	..	R	S	S	S	S	S	S	S	S	S	25

R=Resistant; M=Moderately Resistant; S=Susceptible.

It may be seen that sharply differentiating reaction of the isolates has been obtained with the last three varieties in Table I, *viz.*, P.I. 201902, Wag Wag and Raminad Str. 3, three varieties of the *indica* group. On the basis of comparative studies in different countries it may be possible to have a common set of international differentials with some additional types for local use in each country or region, as for instance, for *japonica* and *indica* rice zones, etc.

Identification of physiologically specialized races of *P. oryzœ* in India is a significant advance as the work of evolving resistant varieties can now be taken up on the basis of the races, occurring in each region. Studies on inheritance of resistance which have not made much progress so far, can also be undertaken with confidence against specific race or races.

1. Padmanabhan, S. Y. and Ganguly, D., *Proc. Ind. Acad. Sci.*, 1959, **50 B**, 289.
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PHYSICO-CHEMICAL STUDIES ON STABILITY OF PENICILLIN SALTS
Part V. Application of Polarographic and Counter-Current Distribution Methods

N. NARASIMHACHARI AND G. RAMANA RAO

Hindustan Antibiotics Ltd., Pimpri,

AND

K. S. V. SANTHANAM

Sri Venkateswara University, Tirupati

IN earlier papers in this series[1][3] it was shown by spectrophotometric studies that trace contamination by penicillenic acid (strong absorption at 320 mμ) was responsible for the low life of sodium penicillin G. The application of polarographic and counter-current distribution methods for the study of stability of penicillin salts is described here.

POLAROGRAPHY

Polarograms were taken of a number of commercial samples of sodium penicillin G according to standard procedures. The sample (0·083 g.) is dissolved in water (100 ml.) and the solution is diluted ten times for the actual determination. Ammonium chloride (1 N., 10 ml.) and ammonium hydroxide (1 N. 10 ml.) are mixed and a stream of hydrogen gas is passed to remove dissolved oxygen. Cobaltous chloride solution (0·015 M., 2 ml.) and sample (3 ml.) are then added. Hydrogen gas is again passed for a few minutes. The polarogram is manually recorded at a sensitivity of 1/100 which is kept constant for all runs. The drop time of dropping mercury electrode is 4 secs. The non-polarisable electrode was a large pool of mercury with a potential of + 0·0716 V. *vs.* saturated calomel electrode. The polarograph employed was of Lange's type B. The applied potential *vs.* current in arbitrary units is shown in polarograms (Fig. 1).

RESULTS AND DISCUSSION

The catalytic waves for sulphydryl groups are taken in ammoniacal ammonium chloride solution containing divalent or trivalent cobalt. In such medium cobaltous cobalt gives a well-defined single wave for which $E_{\frac{1}{2}}$ is about — 1·2 V. This wave (blank, curve 1) is recorded for all the samples. In the case of pure samples of penicillin the curve (curve 2) is very similar to the blank.[1] In impure samples (showing a higher absorption at 320 mμ) the catalytic wave appears at about — 1·4 V and reaches a maximum at — 1·6 V and then decreases as the potential is further increased. This has a half-wave potential of — 1·46. This polarogram is very similar to

that of cysteine under the same conditions where the catalytic wave appears at — 1·4 V and reaches a maximum at — 1·8 V.[5] The quantitative proportionality of the wave height with respect to SH group present is brought out in curves 3 and 4 where a badly deteriorated batch was used at different concentrations. The absence of a catalytic wave in the region — 1·4 to — 1·6 V is an indication of the initial purity (*i.e.*, freedom from penicillenic acid) and consequent storage stability. In a number of determinations with samples of different E values at 320 mμ polarograms of varying catalytic heights were obtained.
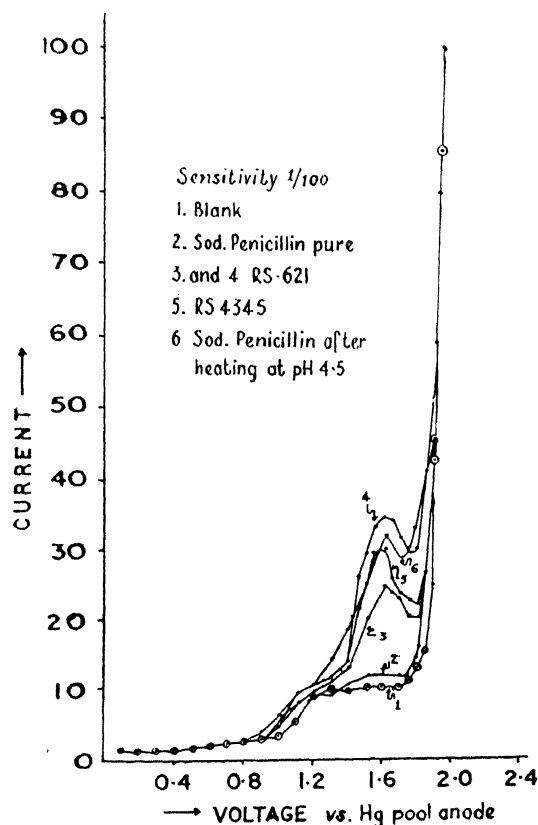
FIG. 1

The identity of the impurity causing the catalytic wave at $-1\cdot4$ to $-1\cdot6$ V as penicillenic acid was independently established by decomposing a pure sample of penicillin by heating a solution at pH $4\cdot5$ and running the polarogram (curve 6). The half-wave potential of the solution after heating at pH $4\cdot5$ was $-1\cdot44$ V, closely agreeing with the value obtained ($-1\cdot46$ V) for impure penicillin.

COUNTER-CURRENT DISTRIBUTION STUDIES WITH PENICILLIN

Counter-current studies on penicillin have been mainly aimed at distinguishing the distribution patterns of different penicillins with a view to find the homogeneity of the product and its freedom from admixture with other penicillins.[7,8] There has not been any report so far in literature about the application of this method for the evaluation of the purity of penicillin and its admixture with decomposition products as contaminants. To get the distribution pattern of benzyl penicillin, penicillenic acid and penicilloic acid, a badly deteriorated batch containing both these impurities was chosen for this preliminary study. The solvent system was chloroform, 2 M phosphate buffer pH $5\cdot0$ (prepared from potassium dihydrogen phosphate 272 g. and sodium hydroxide 18 g. per litre). The substance (75 mg.) was taken and 50 transfers were carried out in Craig's semiautomatic counter-current apparatus (Quickfit and Quartz). Penicillenic acid was determined by absorption at 320 mμ and penicilloic acid by colorimetric method using arsenomolybdate.[9] Penicillin was determined both by iodimetry and absorbance at 260 mμ.

The distribution pattern is given in Fig. 2. The curve for penicillin given here is the calculated curve which was found to be very similar to the experimental curve, the maxima being in 28th tube in the system. Curves for penicillenic acid and penicilloic acid are the experimental curves, from which it can be seen that penicillenic acid has a maxima in the 3rd tube and penicilloic acid in the end tubes with a maxima at 47th tube. The observed K value

for penicillenic acid is $0\cdot49$ and for penicilloic acid it is $23\cdot5$.

Comparing the spectrophotometric method reported earlier[1-3] with the polarographic and counter-current methods described here it can be seen that the ultra-violet absorption method is by far the simplest and dependable method
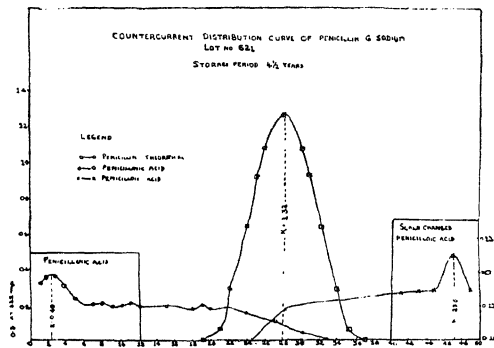
FIG. 2

to evaluate the initial and final purity of sodium penicillin G. Polarography is the next best method for detecting penicillenic acid even in trace amounts. Counter-current distribution is also shown to separate the impurities such as penicillenic acid and penicilloic acid from penicillin G.

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LETTERS TO THE EDITOR

ADDENDUM TO "A QUICK METHOD OF DERIVING WISHART'S DISTRIBUTION"

In my note under the above title published in *Current Science* (1965, Vol. 34, p. 73) there appears the following statement:

".... showing that $f(S) S^{...} P^{-1}$ is independent of the argument, and is therefore a constant."

The latter part of this conclusion needs a little amplification to make the derivation rigorous. Denoting the above ratio by $\psi(S)$, we have it that $\psi(S)$ is independent of the argument S. The function $\psi(S)$ may be merely invariant under the transformation, and the result that $\psi(S)$ is an absolute constant independent of S does not follow immediately. To establish this result, we note that since S is non-singular, it is possible to find non-singular matrices $A_1, \ldots, A_m$ such that $A_m \ldots A_1 S A_1' \ldots A_m' = i$. Consequently when these transformations are applied in succession.

$$\psi(S) = \psi(A_m \ldots A_1 S A_1' \ldots A_m') = \psi(i)$$

which is completely independent of S, so that the assertion that $\psi(S)$ is a constant is rigorously established.

Karnatak University,   M. V. JAMBUNATHAN.
Dharwar, *March* 15, 1965.

THE CURVE OF EARTH'S EQUATOR

Until recently the physical surface of the Earth was closely approximated by a triaxial ellipsoidal geoid and values were obtained for equatorial ellipticity by gravimetric, astrogeodetic and satellite methods. It has now been found from physical geodesy that an ellipsoidal structure is inadequate when higher harmonics of the gravity field are included in the analysis. In this note we wish to examine this conclusion in the light of recent satellite data on the tesseral harmonic coefficients in the geopotential.

The curve of equator is represented by[1]

$$r = R\left[1 + \sum_{n=2}^{\infty} \sum_{m=1}^{n} P_n^m(0) \times J_{nm} \cos m(\lambda - \lambda_{nm})\right] \quad (1)$$

to an accuracy of one part in 10^6 of R, the mean equatorial radius whose value we shall take as $6 \cdot 378165 \times 10^6$ metres following Kozai.[2] In (1), $P_n^m(z)$ is the associated Legendre function defined by

$$P_n^m(z) = \frac{(1-z^2)^{m/2}}{2^n n!} \frac{d^{n+m}}{dz^{n+m}}\{(z^2-1)^n\}$$

and J_{nm}, λ_{nm} are constants whose values are at present known up to $n = m = 4$. Examining the maxima and minima of r and d, the equatorial diameter given by

$$d(\lambda) = r(\lambda) + r(\lambda + \pi),$$

we obtain the results presented in Table I, from which it becomes apparent that the curve of equator differs appreciably from an ellipse. The reason for the deviation can be easily traced to the comparable magnitudes $J_{nm} P_n^m(0)$ have, at least up to the (4, 4) level—a reflection of the high correlations among J_{nm} noted by Izsak.[3] Thus the results of satellite geodesy also indicate the inadequacy of an ellipsoidal model to represent the complicated Earth structure.

In comparing the extent of accord between the results of physical and satellite geodesy we note that computations based on Izsak's values show better agreement, viz., (*i*) the undulations of the geoid do not exceed ± 50 metres in the gravimetric method,[5] (*ii*) direct gravity observations indicate that two of the maximum values in equator differ by about 120° longi-

TABLE I

Author		Max. r	λ^0	Min. r	λ^0	Max. d	λ^0	Min. d	λ^0
Izsak[3]	..	R+24	10·3° E.	R−48	66·5° E.	2R+48	4·9° E.	2R−66	63° E.
		R+29	167·3° E.	R−29	123° W.	2R+19	61° W.	2R+13	38° W.
		R+7	78° W.	R−15	37·3° W.	..	..	..	..
Guier[4]	..	R+21	2·3° E.	R−70	72·8° E.	2R+70	30·6° W.	2R−88	74° E.
		R+64	142·9° E.	R−19	99·7° W.	..	..	..	..

$$\sum_{n=2k=2}^{\infty} \sum_{m=2l=1}^{n=2k} 2l\, P_{2k}{}^{2l}\,(0)\,[J_{2k,\,2l}\sin 2l\,(\lambda-\lambda_{2k,\,2l})] = 0$$

$$\sum_{n=2k=2}^{\infty} \sum_{m=2l=1}^{n=2k} 2l\,(-1)^l\, P_{2k}{}^{2l}\,(0)\,[J_{2k,\,2l}\sin 2l\,(\lambda-\lambda_{2k,\,2l})] = 0$$

$$\sum_{n=2k+1=2}^{\infty} \sum_{m=2l+1=1}^{n=2k+1} (2l+1)\, P_{2k+1}{}^{2l+1}\,(0)\,[J_{2k+1,\,2l+1}\sin \overline{2l+1}\,(\lambda-\lambda_{2k+1,\,2l+1})] = 0 \qquad (2)$$

$$\sum_{n=2k+1=2}^{\infty} \sum_{m=2l+1=1}^{n=2k+1} (2l+1)\,(-1)^l\, P_{2k+1}{}^{2l+1}\,(0)\,[J_{2k+1,\,2l+1}\cos \overline{2l+1}\,(\lambda-\lambda_{2k+1,\,2l+1})] = 0$$

tudinally, the extreme variation being 71 metres,[6] (iii) astrogeodetic evidence leads to a possible pentaxial spheroidal structure for the geoid.[7] Nevertheless the differing number of extrema, their values and longitudes in the case of the two authors point to the need to have better estimates of the coefficients in the potential and independent confirmation[8] from other sources when possible.

The problem however does not stop at this stage; an accurate knowledge of the shape of equator will be obtained only when a state of null-correlation prevails among the coefficients in the potential and the coefficients are accurately evaluated.

If the curve of equator possesses consecutively orthogonal extreme radii, then the above equations (2) must be simultaneously satisfied for the same value of λ; the first and the third must be satisfied if the equator has orthogonal extreme diameters. It is interesting to note that, when the present values are substituted in these equations, neither of the criteria are satisfied, showing clearly that the equator is "non-elliptical".

The author wishes to acknowledge his deep gratitude to Dr. K. S. Viswanathan for useful discussions; grateful thanks are also due to the Director, National Aeronautical Loboratory, for encouragement and permission to publish this note.

National Aeronautical Lab.,   N. RAJAPPA.
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COMPOSITION AND STABILITY CONSTANT OF URANYL-2-HYDROXY, 3-NAPHTHOIC ACID COMPLEX

THE complex formation of uranium with 2-hydroxy, 3-naphthoic acid has been studied and its composition established by Job's method of continuous variation,[1] molar ratio method[2] and slope ratio method.[3] The complex attains its maximum intensity at pH 4·0 and contains uranyl and the reagent in 1 : 1 ratio, the colour of the complex being red.

The absorbances of mixtures containing uranyl nitrate and the reagent in the ratio 1 : 1 at different pH's were measured at 460 mμ. The maximum absorbance was at pH 4·0. The complex is highly sensitive even to a small change in the pH. The curves of absorbance *vs.* wavelength for 1 : 1, 1 : 2 and 1 : 3 ratios of uranium to the reagent at pH 4·0 were practically identical in shape, thus suggesting the formation of only one complex under the condition of the study. Molar composition of the complex as determined (λ-460 mμ) by Job's method of continuous variations was also found to be 1 : 1. Harvey and Manning's slope ratio method also suggested the formation of 1 : 1 complex as the curves obtained were parallel. Molar ratio method also indicated the formation of 1 : 1 complex, indicated by a break at the mole ratio of 1 : 1. There is a very gradual rise in absorbance indicating appreciable dissociation of the complex. The values of E_m and E_s are respectively 0·2965 and 0·1196. Using Harvey and Manning's formula the value of a comes out to be 0·5966 and from this, the value of the dissociation constant (K_a) of the complex obtained is $3·529 \times 10^{-4}$ and that of the stability constant $K' = 1/K_a = 2·834 \times 10^3$. The standard free energy of formation of the complex at 25° C. as calculated from the relation $\Delta F° = -RT\ln K$ comes out to be $-4·732$ K. Cal./mole. Molecular extinction coefficient is $6·25 \times 10^2$. The complex obeys the Lambert-Beer's law from

·0·05 × 10⁻³ to 1·3 × 10⁻³ moles /lit. of uranyl ions.

It was noted that the conductance of the mixture was higher than the sum of the conductances of the components. This is probably due to the liberation of hydrogen ions as a result of the complex formation. The reaction can be represented by :

$$UO_2^{++} + C_{10}H_6 \diagdown \begin{smallmatrix}OH\\COOH\end{smallmatrix}$$

$$\rightarrow \left[C_{10}H_6 \diagdown \begin{smallmatrix}O\\COO\end{smallmatrix} \diagup UO_2 \right] + 2H^+$$
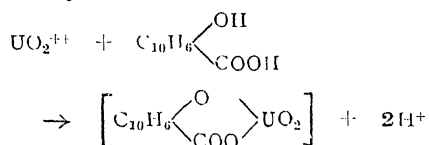
Thanks are due to Professor B. K. Vaidya for his keen interest in the work.

Chemistry Department, M. N. DESAI.
Univ. School of Sciences,
Gujarat University,
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MODIFIED HILL-PIPER DIAGRAM FOR REPRESENTING WATER ANALYSIS DATA

IF one considers only the major dissolved constituents and lumps together certain dissolved ions whose properties are to some extent similar, the composition of most natural waters can be represented as consisting of three cationic constituents calcium, magnesium and the total alkalies and of three anionic constituents sulphate, chloride (*plus* nitrate) and those contributing to alkalinity. The composition of water can be represented by trilinear plotting in two separate triangles, one for the cations and the other for the anions.

Several authors have, however, suggested a third plotting field that represents a projection of the triangles into a common area, where the analysis can be represented by one single point. The position of this single point depends upon the concentration of different cations relative to each other and that of the anions with respect to one another. While Hill[4] and Piper[5] used a diamond-shaped area for projection, Durov[3] used a rectangular field.

Durov's method is somewhat complicated as one has to use two different sets of co-ordinates, trilinear and rectangular in the same graph, but has the advantage that unlike the Hill-Piper method, the triangles can be split[1] so that the chemical characteristics can be represented in a clear manner in the rectangular field. Both these methods, however, suffer from the drawback that the salinity of water cannot be represented properly. Further no idea of the suitability of water for irrigation purposes can be obtained. Piper had suggested that the plotted position of waters should be represented by circles, the diameter of the circles being proportional to the total dissolved salts concentration expressed in parts per million. This method, however, is not practicable where waters plot near to each other in the diamond diagram.

Burdon[2] has suggested the use of another field in conjunction with the Durov diagram to represent the salinity of water. His method, however, fails to give any idea of the sodium hazards to be expected from waters.

Recently the author[6] proposed a modification of the U.S. Salinity Research Laboratory diagram for classification of ground-waters for irrigation purposes, in which instead of the sodium adsorption ratio, the sodium concentration is plotted against salinity. Further the S_3 line was eliminated as superfluous, and the diagram was divided by two curves S_1 and S_2 only, depending upon the sodium hazards to be expected from irrigation waters. In a recent paper[7] the author has proposed another modification by which the alkaline earth concentration is plotted against salinity. By incorporating his diagram, it is not only possible to show the composition of water and its salinity but also an approximate idea about its suitability for irrigation purpose can be obtained.

TABLE I

Composition of some waters expressed as percentage of total cationic and anionic concentrations respectively

Sl. No.	Ca %	Mg %	Na+K %	HCO₃ %	SO₄ %	Cl %	T. D, S. mcq./l.
1	32·9	22·0	45·1	60·9	9·3	29·8	8·20
2	40·0	20·1	39·9	94·7	0	5·3	7·66
3	52·9	15·8	31·3	94·8	3·0	2·2	8·31
4	44·8	32·0	23·2	96·1	0·3	3·6	7·82
5	2·7	0·4	96·9	61·2	21·4	17·4	9·36
6	17·5	15·5	67·0	70·1	21·3	8·6	8·56
7	42·8	21·1	36·1	92·0	4·1	3·9	6·87
8	43·8	19·3	36·9	88·8	8·0	3·2	6·85
9	60·2	19·0	20·8	85·7	9·5	4·8	6·48
10	66·3	20·3	13·4	92·7	3·6	3·7	5·98
11	67·8	27·6	4·6	82·6	4·9	12·5	6·55
12	35·0	45·7	19·3	86·5	6·4	7·7	9·00
13	8·9	19·2	71·9	74·8	9·3	15·9	12·88
14	6·8	6·9	86·3	65·7	19·2	15·1	19·00

In Table I the composition of some waters analysed by the author is given. By plotting

these in the modified Hill-Piper diagram proposed here (Fig. 1) it is obvious that it is
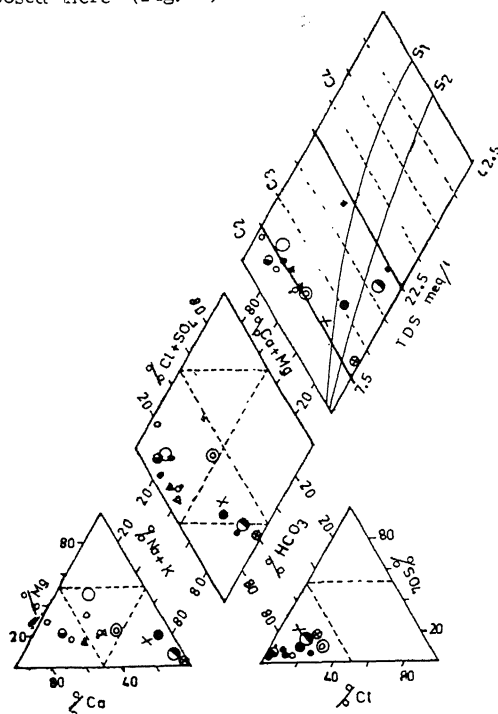
FIG. 1. Modified Hill-Piper diagram for depicting water analysis data.

possible to get much more precise information about water than is possible from the original diagram alone. In the present instance, for example, one not only gets the information that these ground-waters are of the bicarbonate type, an information which would be available from the original diagram, but also that the salinity of water generally lies around 7·5 meq./l. Further majority of the samples plot above the S_1 line and as such present no sodium hazards. Needless to say, the same modification can also be applied to Durov's diagram.

28/12 A, Dhakuria Station Road,   B. K. HANDA.
Dhakuria, Calcutta-31,
February 13, 1965.

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SOME BIOCHEMICAL OBSERVATIONS ON AN ACID-FAST MICRO-ORGANISM ISOLATED FROM HUMAN LEPROMATOUS LEPROSY

BAPAT *et al.*[1] first reported *in vitro* cultivation of an acid-fast organism isolated from four cases of lepromatous leprosy in 1958. Detailed report on *in vitro* behaviour of the cultivated organisms followed later (Bapat *et al.*[2]). These strains of micro-organism are designated as 'ICRC' bacilli (Indian Cancer Research Centre bacilli). Bacteriological studies on these bacilli have been carried out by Ganguli.[3] Investigations on the pathogenicity and immunological studies of these bacilli have been reported by Ranadive *et al.*,[4] Ranadive,[5] and Rao *et al.*[6] respectively. Some nutritional aspects of the bacillus have been investigated by Nadkarni and Coutinho[7] and Mashelkar and Bhat.[8]

ICRC bacilli cultivated in the conditioned fluid of the tissue culture cells (modified fluid[1]), is used in the present study. During the course of studies on the maintenance of ICRC bacilli *in vitro*, it was observed that these organisms grew luxuriantly in the modified fluid but not on the routine Basal Medium of Eagle, supplemented by either human or horse serum.[7] It was assumed that certain metabolites such as keto-acids and lactic acids may be more essential for their growth and maintenance than glucose. To determine the levels of these constituents in the medium, modified fluid as control and modified fluid after incubation with the bacilli at 37° C. for the period of 22 to 37 days has been used. Since the exponential phase and phase of decline lies between 20 and 40 days,[7] 22 and 37 days intervals were selected.

The technique used for protein estimation is that of Oyama and Eagle.[9] Lactic acid estimations are carried out by the method of Barker and Summerson[10] and keto-acids estimations by Friedemann's technique.[11] Glucose is determined by the procedure of Trevelyan and Harrison.[12] The results in mean values are presented in Table I.

It is observed that there is no appreciable change in the level of protein in the medium even after 37 days. This happens to be in agreement with chromatographic studies of amino-acids.[8] A decrease in the levels of glucose from 41·0 mg.% to 25·32 mg.% and 21 mg.% indicate the utilisation of glucose to the extent of only 10–40% suggesting very slow glycolysis. The accumulation of lactate in the media at the end of 22 days shows the downward trend till 37

TABLE I

Analysis of modified fluid before and after incubation with ICRC bacilli at 37° C. for 22 days and 37 days

	Total protein (gm. %)	Glucose (mg. %)	Glucose utilised (mg. %)	Lactic acid (mg. %)	Lactic acid produced (mg. %)	Total Keto-acids (mg. %)	Keto-acid utilised (mg. %)
1 Modified fluid before incubation ..	1·000	41·08	..	29·04	..	4·25	..
2 CASE I:							
Used M.F. after incubation for 22 days	0·958	26·25	14·83	40·80	11·76	3·94	0·29
3 CASE IV:							
Used M.F. after incubation for							
22 days ..	0·911	24·06	17·02	32·80	3·76	3·56	0·69
37 days ..	1·020	17·50	23·58	31·00	1·96	2·16	2.09
4 CASE V:							
Used M.F. after incubation for							
22 days ..	0·986	35·00	6·08	38·40	9·36	3·49	0·76
37 days ..	0·934	22·19	18·89	35·20	6·16	2·59	1·66
5 CASE X:							
Used M.F. after incubation for							
22 days ..	0·925	25·93	15·15	40·20	11·16	2·92	1·33
37 days ..	0·944	21·25	19·83	34·10	5·06	3·05	1·20

days. Decrease in keto-acids indicate that they are being utilised. Except in Case V, in other cases the amount of glucose utilised at the end of 22 and 37 days are more or less the same and the data are comparable with the growth phases.[7] The average decrease in the ratio of lactic acid production to the amount of glucose utilisation may mean that either lactate is also being used or accumulation of lactate would interfere with the rate of glycolysis. Lactate could also be used to meet energy requirements of the organisms since it was observed that *M. leprœ* utilises lactate (Prabhakaran[13]). The levels of keto-acids utilisation is increased in all the cases except in Case X, wherein it is somewhat maintained. This indicates that the total keto-acids are utilised for growth and maintenance.

Applied Biology Group,   V. R. TALAGERI.
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OCCURRENCE OF "EXPLOSION BRECCIAE" AT DRANG, MANDI DISTRICT HIMACHAL PRADESH, INDIA

THE authors wish to record the occurrence of "explosion brecciæ" for the first time from the "Mandi traps" exposed near Drang (31° 48′ N. : 76° 57′ E.), Mandi District, Himachal Pradesh. Drang is situated on Pathankot-Mandi highways and lies on the survey of India one inch sheet No. 53 A/13. The explosion brecciæ occurs in masses of 2 to 5 metres in thickness and extend for several hundred metres near the southern margin of the trap. The rock is structureless and does not show any plane or lamination. The brecciæ (Fig. 1) consist of angular to sub-rounded fragments of grey or greyish-white quartzite, a few of which show banding or lamination. A few isolated grains also show rounded outlines.

The rock is greyish-green mottled with white or greyish-white colour. It contains fragments of quartzite which measure from a few mm. to 3 cm. in length and up to 2 cm. in width. The greenish-grey matrix is composed of very fine-grained ground mass and the junction between

the xenoliths and the ground mass is from sharp to irregular. The rock is compact, hard and breaks with sub-conchoidal fracture. It has a subvitreous lustre, gives a gritty feel, and is of average specific gravity 3·2.
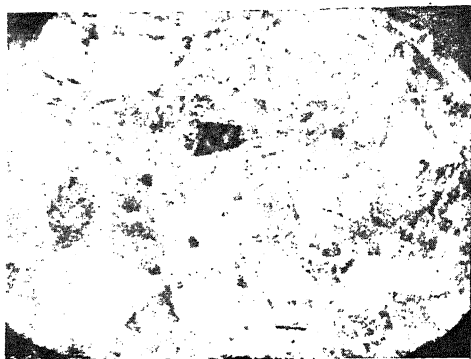
FIG. 1, × 2.

Under the microscope the rock is crypto-crystalline in which angular to sub-rounded, partly fused fragments show variable shapes and sizes. The ground mass is composed of cryptocrystalline to glassy matrix which is rich in iron oxide and contains pinnite-forming microgeode-like structure.

The angular to sub-angular siliceous fragments varying in size show a gradational junction with matrix under microscope which is often marked by a rim of chalcedony under ordinary light. Siliceous fragments are colourless and show two sets of trails formed by opaque dusty inclusions representing earlier healed fractures. Later fractures are occupied by yellowish matrix. Under cross-nicols the fragments show a cryptocrystalline nature mostly composed of chalcedony (Fig. 2). At times crystal
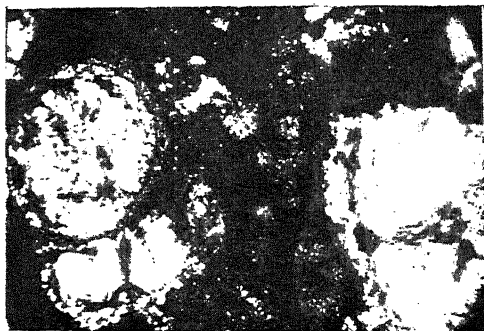
FIG. 2, × 10.

aggregates of quartz surrounded by crypto-crystalline matrix are also observed. The

quartz grains measure up to 2·5 mm. Chalcedony often occurs as spherulites (Fig. 2) within the cryptocrystalline siliceous mass. The crypto-crystalline silica shows weak birefringence ranging from greyish-white to bluish-grey and chalcedony often shows a spherulitic cross (Fig. 2).

Pale yellow to yellowish-green flakes of pinnite occur as tiny wisps in the ground mass or form crystalline aggregates surrounded by a rim of iron oxide, giving rise to a geode-like structure. The mineral is feebly pleochroic and gives anomalous berlin blue polarization colours.

Explosion brecciæ have been described from other parts of the world. The works of Riche,[1] Reynolds[2] and Hughes,[3] are worth mentioning.

The field and laboratory studies of the rock suggest that during the upwelling of Mandi traps the forceful outburst of the gas and lava caused shattering of the country rock, in the present case banded quartzites, which were ingulfed and carried to the surface in suspension. The inclusions show least effect of metamorphism except those which are partly vitrified and are such as described under the name of buchite.[4]

The angular to sub-angular nature shows that the brecciæ represent marginal part of the rock body.[5] In the present case it appears that initial fragmentation was followed by intrusion of liquid rather than steaming long volume of gas through the fragments. The angular and vitrified nature is in support of our observations.

Department of Geology,   I. C. PANDE.
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INHIBITION OF OVULATION AND SPAWNING BY ADRENALECTOMY IN SKIPPER-FROG, *RANA CYANOPHLYCTIS* (SCHN.)

IT has been observed that in amphibia the pituitary, thyroid and adrenals are active during breeding season[1,2] but their *modus operendi* on ovulation and spawning has remained problematical. Administration of pituitary extracts, gonadotropins, thyroxine, androgens, progesterone and adrenocortical steroids to gravid frogs

TABLE I

Treatment	% Mortality	% Spawning	% Body weight difference	Weight (gm.)/100 gm. Body weight ± Standard Error			
				Ovary	Oviduct	Liver	Kidney
Non-operated controls (12)	0	83·3	− 2·1	2·82±0·40 (12)	1·47±0·23	1·81±0·12	0·66±0·99
Sham-operated controls (18)	16·67	86·7	+ 6·5	3·49±0·49 (15)	1·41±0·17	1·75±0·12	0·58±0·09
Partial adrenalectomized (11)	9·09	90·0	+ 5·4	3·70±0·40 (10)	1·51±0·17	1·81±0·10	0·39±0·07
Adrenalectomized (20)	45·0	0	+23·5	4·63±0·80 (11)	2·44±0·85	2·36±0·28	0·77±0·14

Number in parenthesis denotes number of frogs.

induce ovulation and spawning both *in vivo* and *in vitro*, indicating a consummate effect of all the endocrine organs.[3-5] In hypophysectomized frogs only a few adrenocorticoids cause ovulation and spawning,[6] thereby indicating that adrenals may play a vital role in the process. As there is no direct evidence, the present investigation was undertaken.

Gravid, skipper-frogs weighing 25–35 gm. were kept in aerated aquaria at a temperature of 20–25° C. and were fed with minced frog thigh muscles. The adrenals are of a diffused nature, appearing as an irregular strip of yellowish tissue, on the mid-ventral surface of the kidney. Therefore, adrenalectomy was performed by a method of thermo-electric cautery under ether anæsthesia.[7] In sham-operated controls cauterization was done on the kidneys just by the side of the adrenals. In partial adrenalectomized frogs only half of the adrenal tissue on both the kidneys were cauterized. Non-operated controls were also used to note the normal spawning response. As adrenalectomy affects the salt metabolism,[2] all the test animals were given 1 ml. of 1% saline per frog per day subcutaneously. Two days after operation, a dose of 4 homoplastic homogenized pituitaries per frog was injected intraperitonially in 1·5 ml. of distilled water and the spawning response was noted on the next day. A booster dose of 2 pituitaries per frog was given to those which failed to spawn and the incidence of spawning was noted after 24 hours. Later, all the frogs were autopsied by pithing; ovaries, oviducts, kidneys and liver were dissected out, weighed to the nearest mg., fixed in Bouin's fluid, sectioned at 10 μ thick and stained in Harris hæmatoxylin-eosin and Mallory's triple stains. The experiment was repeated 6 times, using a total of 61 frogs.

The results indicate profuse spawning in non-operated and sham-operated controls, the per cent incidence being 83·3 and 86·7 respectively. A few controls which did not spawn possessed immature ovary. All the adrenalectomized frogs failed to spawn even with the booster dose of pituitary (Table I), despite they possessed gravid ovary. It is interesting to note a slight increase in the per cent incidence of spawning in partial adrenalectomized frogs, which may be due to hypersecretion of the remaining portion of the adrenals, caused by the stress of operation. The failure of spawning in adrenalectomized frogs may not be due to the damage caused to kidney tubules, because the renal damaged controls have spawned. Therefore the cause of inhibition should be attributed to the adrenal insufficiency. The histological observations of the kidneys of adrenalectomized frogs show complete destruction of adrenal cells with a slight damage to the kidney tubules while sham-operated controls show intact adrenal cells with damaged urinary tubules. Adrenal ablated frogs suffered from edema and asthenia followed by significant increase in body weight. Mortality was also high. Similar observations have been made in adrenalectomized frogs and toads by earlier workers.[2] There is increase in the weights of ovary, oviduct, kidney and liver in adrenalectomized frogs, probably due to edema; however, this increase is not statistically significant.

Witschi and Chang[5] hypothesized that for the release of ova from a gravid ovary, adrenocortical steroids are essential. This is supported by the observations of Ramaswami and Lakshman[6] who showed that only Desoxycorticosterone Acetate (DOCA) brings about ovulation and spawning in hypophysectomized frogs, even 10 days after operation; at which time adrenals will have dwindled.[2] Here DOCA may act directly on the ovary, to release the ova. However, it is rather difficult to explain the release of ova *in vitro*, by pituitary extracts

(in the absence of adrenocortical steroids). Wright[8] is of the opinion that the pituitary gonadotropins stimulate the ovaries to synthesize some ovulatory steroid, which brings about ovulation. But the histochemical studies of Pesonen and Rapola[10] indicate that adrenals are the main source of ovulatory steroids.

In the light of these observations, the present experiment gives a direct evidence for the vital role played by adrenals for successful ovulation and spawning. Further, these studies may be helpful for artificial breeding of frogs.

This research is supported by U.G.C., Mysore University and Ford Foundation grants, for which we are highly indebted.

Physiology of   S. R. KANAKARAJ.
   Reproduction Wing.   M. APPASWAMY RAO.
Department of Zoology,   H. B. D. SARKAR.
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A NEW SPECIES OF *SPOROTHRIX*

A NEW species of *Sporothrix*, *S. albicans* sp. nov. is described. It was isolated from Kettering loam which was being used for fumigation experiments at the Botany School, Cambridge.

Sporothrix albicans SP. NOV.

Coloniæ albæ paulisper zonatæ, diametrum attingetes 3-4 cm. in agaro Czapek post dies 10 ad 26° C. Hyphæ repentes irregulariter ramosæ; conidiophori emergunt ut ramuli mycelii variabiles magnitudine, conidia supportantes ad nodos et apices. Conidia insidentia hyphis ad intervalla, plurima, hyaline, rotundata vel oblonga, sessilia vel phialidibus parvis insidentia; rotundata quidem $1 \cdot 5$-3μ diam., oblonga vero $2 \cdot 28$-$4 \cdot 56 \mu$. Lecta ex solo ad Cantabrigiam in Anglia. Typus: Herb. IMI 80677.

Sporothrix albicans SP. NOV. (FIG. 1)
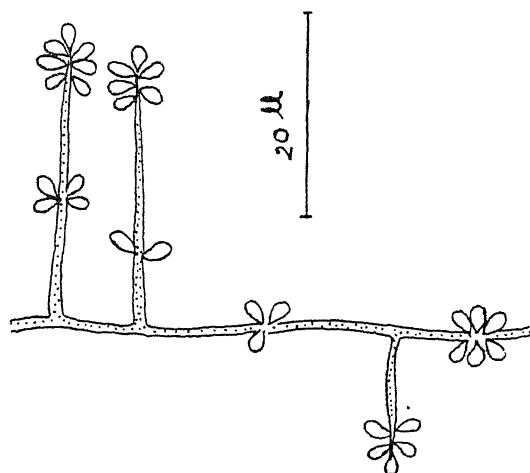
FIG. 1. Conidiophore with conidia, conidia borne at the apices and at the nodes, × 1,500.

Colonies white, slightly zonate, attaining 3-4 cm. diam. on Czapek's agar in 10 days at 26° C. Repent hyphæ irregularly branched, conidiophores arise as branches of the mycelium, variable in size and bearing conidia at the nodes and apices. Conidia borne on the hyphæ at intervals, very numerous, hyaline, rounded to oblong, sessile or on small phialides. Rounded conidia $1 \cdot 5 \mu$ diam., egg-shaped $2 \cdot 28$-$4 \cdot 56 \mu$.

From soil, Cambridge, England. The culture has been deposited at the Commonwealth Mycological Institute, England, as IMI 80677.

The author expresses his thanks to Mr. J. J. Elphick, Commonwealth Mycological Institute, for the help in the identification of the species and to Dr. H. Santapau for the Latin diagnosis.

Department of Botany,   S. B. SAKSENA.
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VIVIPARY IN AN INLAND XEROPHYTE (*CAPPARIS SEPIARIA* LINN.)

Capparis sepiaria (Capparidaceæ) is commonly found in dry places throughout India and flowers in the month of May and the fruits mature in July. The matured fruit is a berry measuring 10-11 mm. in diameter, black in colour and contains one mature seed. When the fruit is not detached from the plant, the pericarp cracks and the embryo germinates inside and becomes green. The two plicately folded cotyledons are adpressed closely. The hypocotyl elongates, spirally coils, and assumes a darker green colour. It is about 10-11 mm. long, narrow and flattened with a groove inside.
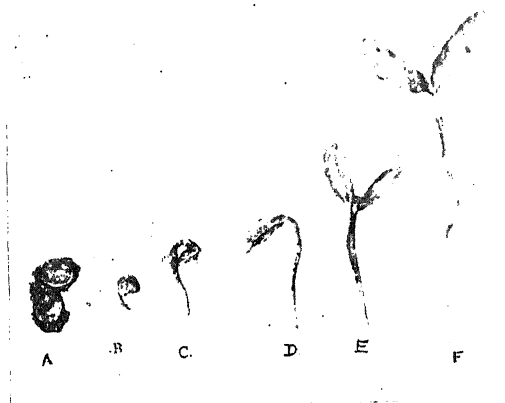
FIG. 1. (A) Germinating seedling inside the fruit (B) The spirally coiled seedling. (C and E) The development of the embryo without formation of the root. (F) A seedling with root and shoot.

In this condition, the seed drops on the ground in the rainy weather, and the seedling lies in a coiled state; the radicle does not appear to germinate at this stage. The seedling gradually becomes straight, with the cotyledons still adhering closely to each other, without the germination of the radicle. In this condition the seed with its green hypocotyl remains alive for nearly 3 weeks or more and sparrows aid in the dispersal of the seedling. On suitable soil, the radicle grows and anchors the seedling which by now becomes erect with the cotyledons spread out.

Our experiments to grow plants from the seedling locally and elsewhere have proved successful.

Notable features in viviparous germination of this plant are: (i) Embryo becomes green, and thus appears to do photosynthesis; and becomes spirally coiled. (ii) The seedling drops from the fruit and is dispersed by the agency of birds. (iii) It takes one month for the seedling in the fruit to assume an erect position (middle of July to middle of August).

Various stages of the viviparous seedling were collected during the months of July to August, 1963.

I am grateful to Prof. N. M. Mukerjee for valuable guidance in preparing this note. I am also thankful to Dr. S. S. Saxena, Principal, for giving me necessary encouragement.

Botany Department,   R. N. GUPTA.
Govt. Science College,
Gwalior (M.P.), India,
November 20, 1964.

POLLEN MORPHOLOGY OF TWO SPECIES OF ACANTHACEAE

THE present study refers to the pollen morphology of two commonly occurring species of South India, *viz.*, *Justicia prostrata* (Cl.) Gamble and *Rungia repens* Nees.

According to Gamble (1957) the former is widely distributed in the Circars and Carnatic extending southwards up to S. Travancore, usually growing in sandy places, while the latter is found in N. Circars, in Godavari and Kistna, Deccan and N. Carnatic, in all districts west to the foot of the Ghats. In Hyderabad the above two species are abundant as annual weeds.

Pollen morphology of the above two species is based on fresh polliniferous material. The material has been suspended in glacial acetic acid and acetolyzed. Part of the acetolyzed material has been chlorinated. Both acetolyzed and chlorinated materials have been mixed and mounted in glycerine jelly (Erdtman, 1960 ; Raj, 1961). All measurements are a mean of about 20-30 acetolyzed pollen grains. The terminology used is that of Erdtman *et al.* (1961), Raj (1961).

Justicia prostrata (Cl.) Gamble (Figs. 1 and 2).— Pollen grains 2-porate (there is an indication of faint colpus at each aperture); bilateral $(25 \times 17 \times 12 \mu)$.

Pores lalongate (about $2 \times 3 \mu$); membrane sparsely granular.

Exine about 2μ thick at poles, up to 6μ at equator. Sexine 1μ thick at poles, 3μ at equator.

Trema area longitudinal $(17 \times 6 \mu)$, provided with more or less circular insulæ (about 1.5μ), with a reticulate pattern. Peripheral area tectate. Tegillum less than 0.5μ thick, slightly

undulating and appears to be formed by the amalgamation of branched bacula (their bases free, forming a supporting layer). Nexine homogeneous, inner margin smooth.

FIGS. 1–6. Figs. 1–2. *Justicia prostrata* (Cl.) Gamble × 2,000. Fig. 1. Surface view of the pollen grain showing pore, faint colpus and insulæ in the trema area. Fig. 2. Optical section. Figs. 3–6. *Rungia repens* Nees, × 1,500. Fig. 3. Surface view of the pollen grain showing pore, faint colpus, insulæ in the trema area and bacula in the peripheral area. Fig. 4. Optical section. Fig. 5. E_2 view showing bacula and punctæ. Fig. 6. Optical section.

Rungia repens Nees (Figs. 3–6).—Pollen grains 2-porate (there is an indication of a faint colpus at each aperture), bilateral (39 × 25 × 19 μ); membrane sparsely granular.

Pores lalongate (about 3 × 4 μ).

Exine about 3 μ thick at poles, up to 6 μ at equator. Sexine about 1·5 μ thick at poles, 4 μ at equator, punctitegillate in the peripheral area. Tegillum about 0·5 μ thick, slightly undulating, supported by bacula. Bacula branched at the apex and gradually shorter towards apertures.

Trema area longitudinal (25 × 12 μ), studded with circular, finely reticulate insulæ (diameter about 2–3 μ), which coalesce towards the poles. Nexine homogeneous, inner margin smooth.

I am very grateful to Prof. M. R. Suxena, for his encouragement and keen interest.

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'LOOP-FORMATION' IN *HETEROTHRIX ULOTRICHOIDES* PASCHER

THE occurrence of genus *Heterothrix*, a member of the Xanthophyceæ, was first recorded in India by the authors.[3] On further examination of the species *Heterothrix ulotrichoides*, an unknown interesting morphological feature was seen. It is being described here.

It was found that, at times, an intercalary cell divides longitudinally in a plane parallel to the long axis of the filament, thus producing two daughter cells in the same transverse plane (Fig. 1). The two daughter cells then undergo repeated transverse divisions (Fig. 2) in the usual manner. The two rows of cells thus produced in intercalary position remain connected with the main filament on both sides. In this way, a small 'loop' with a diamond-shaped or elongate vacant area, surrounded by rows of cells on either side, is produced. Further continued transverse divisions may produce 'loops' of much larger size (Figs. 3–5). Sometimes, growth in the two arms of the 'loop' is unequal so that the resulting 'loop' is asymmetrical.

Occasionally, the process may be repeated in one or both arms of an existing 'loop' (Fig. 6). These on further growth, may ultimately produce a net-like appearance of an originally uniseriate, filamentous, unbranched alga.

'Loop-formation' has been recorded in certain members of the Ulotrichales, *e.g.*, *Uronema*. Similar stages formed by longitudinal divisions are also known to occur in *Tribonema inter-mixtum*, *T. vulgare*, *Bumilleria klebsiana*, etc.[2] It is of interest to note that members of families

FIGS. 1-6. *Heterothrix ulotrichoides* Pascher. Fig. 1. A portion of a filament showing longitudinal divisions in cells, forming the initial stage in 'loop'-formation. Fig. 2. Another filament showing transverse divisions in the two cells formed after longitudinal division. Figs. 3-5. Filaments showing stages in 'loop'-formation. Fig. 6. A filament showing formations of secondary 'loops' in the two arms of an older 'loop'.

Ulotrichaceæ and Heterotrichaceæ which are believed[1] to show parallelism in evolution, exhibit similarity in this feature also.

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YELLOW MOSAIC OF *ACALYPHA INDICA* L.—A NEW WHITE FLY TRANSMITTED VIRUS DISEASE FROM INDIA

Acalypha indica a common garden weed of Delhi has often been found to be affected with a disease the symptoms of which suggested its possible viral nature. The disease is very widespread, and almost all plants seen were found to be affected.

The symptoms of the disease as observed in nature comprise of vein-clearing in the early stages, and this is soon followed by small yellow spots which increase in size with age. The yellow spots coalesce and produce a more or less typical chlorosis. The mottling of contrasting yellow and green areas becomes prominent as the plants grow older (Fig. 1). In severely infected cases, the leaf size is very much reduced and the affected leaves at times show slight puckering (Fig. 2). In external symptoms, the disease has close resemblance to yellow mosaic of bean (*Dolichos lablab* L.).

FIGS. 1-2. Fig. 1. A plant of *Acalypha indica* showing typical symptoms of yellow mosaic virus. Fig. 2. Healthy and infected leaves of *Acalypha indica* showing yellowing, mottling and reduction in the size of lamina.

The disease is easily transmissible by grafting and the incubation period varies from 9 to 15 days. It is also transmitted by *Bemisia tabaci* Gen. and the time taken for typical symptoms to develop on inoculated plants ranges from 12

to 15 days. Successful transmission was also accomplished by the agency of dodder (*Cuscuta reflexa* Roxb.) and the incubation period in this case was found to be six weeks. Transmission of the disease through the aphids, *Aphis crassivora* Koch. and *Aphis gossypii* Glover was not successful. All attempts to transmit the disease through various methods of mechanical inoculation with sap extracted from infected leaves have been unsuccessful.

In the host-range studies in addition to several economic plants some weeds which are known to show symptoms similar to those observed on *Acalypha* were included. It is evident from the host-range studies that the virus is restricted to the genus *Acalypha*. The virus failed to infect the following cultivars and weeds.

Euphorbiaceæ :	*Croton sparsiflorus* Morong.
	Euphorbia hirta L.
	Poinsettia pulcherrima R. Grah.
	Phyllanthus albicans Wall.
	Ricinus communis L.
Malvaceæ :	*Abelmoschus esculentus* (L.) Moench. vars.
	Pusa Swani, Pusa Makhmali, Shankarpath and Meruteru.
	Hibiscus rosa-sinensis L.
	Malvaviscus arboreus Cav.
	Malvastrum tricuspidatum A. Gray.
Amarantaceæ :	*Gomphrena globosa* L.
	Celosia cristata L.
Solanaceæ :	*Solanum tuberosum* L. var. President.
	Nicotiana tabacum L. vars. White Burley and Harrison's Special.
	Nicotiana glutinosa L.
	Lycopersicon esculentum Mill.
	Capsicum annuum L.
Leguminaceæ :	*Phaseolus aureus* Ham. var. NP. 59.
	Phaseolus mungo L. var. NP. 4.
	Phaseolus aconitifolius Jacq.
	Vigna sinensis Savi.
	Crotalaria juncea L.
	Cajanus indicus Spring. vars. NP. (W.R.) 15 and NP. 24.
Nyctaginaceæ :	*Bougainvillœa spectabilis* Willd.
Chenopodiaceæ :	*Chenopodium amaranticolor* Coste and Reyn.

A review of literature revealed that the only record of a virus disease on the genus *Acalypha*

was that made by Van Velsen.[1] He recorded a disease with typical Witches' Broom symptoms on *A. wilkesiana*. The present disease on *A. indica* is different from the one on *A. wilkesiana* in its symptoms and properties and, therefore, forms the first record of a new virus disease on this host.

The authors wish to express their grateful thanks to Dr. B. L. Chona for encouragement and providing necessary facilities.

Division of Mycology and   V. V. CHENULU.
    Plant Pathology,   H. C. PHATAK.
Indian Agricultural
    Research Institute,
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SORDARIA HUMANA (FUCK.) WINT., A NEW RECORD TO INDIA

SIX species of *Sordaria* have been reported from India on dung of various animals mainly from Punjab. Recently there has been a report of *S. fimicola* from Hyderabad Deccan on cow dung.

The species of *Sordaria* described in this paper, identified as *Sordaria humana* (Fuckel) Winter, was isolated from decaying cherry fruits collected in Kashmir in the month of June, 1963. This species was also recorded by Cain and Groves (1948) from *Zea mays* L. seeds. It would thus appear that this species is a common saprophyte. In this connection it may be said that the author has also collected two species of the related genus *Pleurage*, one on decaying hut straw and the other on cattle dung in Lucknow.

A short account of culture studies and a detailed taxonomic description of the fungus identified as *Sordaria humana* (Fuck.) Winter are given below.

Colonies on Potato Dextrose Agar and Czapek-Dox Agar white to ash brown in colour producing abundant perithecia in a week's time on P.D.A. and in about 10–12 days on Czapek-Dox Agar (Fig. 1). Perithecia dark brown to black, superficial or slightly submerged, flask-shaped, 510–560 $\times$ 350–450 μ, ostiolate, ostiole situated on a long beak. Beak 128–160 $\times$ 90–116 μ, perithecia fixed to the substratum by means of rhizoidal outgrowths. Asci cylindric to clavate, bitunicate, apically porate, arising from the base of the perithecium 144–160 $\times$ 14–18 μ. Paraphyses absent. Ascospores globose to sub-globose, hyaline when young, dark brown at

maturity, 20–24 × 14–18 μ typically porate at one end. Slides have been deposited in the Commonwealth Mycological Institute under accession No. I.M.I. 107731-107733.

FIG. 1. Colony on Czapek-Dox Agar.
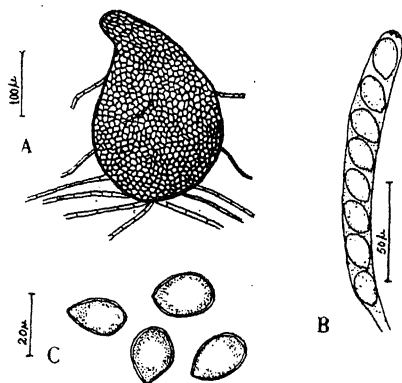
FIG. 2. A. Perithecium, B. An ascus, C. Ascospores.

In its diagnostic features, this fungus resembles *Sordaria humana* described by Cain and Groves,[2] Moreau[4] and Ellis and Everhart.[3] *Sordaria humana* is recorded elsewhere but so far as is known this is the first record of this fungus in India.

Thanks are due to Professor M. N. Kamat for guidance, to Professor K. N. Kaul, Director, for encouragement and to Dr. J. C. F. Hopkins, Director, Commonwealth Mycological Institute, for confirmation of the identity.

Mycology Section,   (MISS) I. K. KALANI.
National Botanic Gardens,
Lucknow, *December* 3, 1964.

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2. Cain, R. F. and Groves, J. W., *Can. J. Res.*, 1948, **26 C**, 486.
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THE GENUS *RHACOMITRIUM* BRID. IN WESTERN HIMALAYAS

THE genus *Rhacomitrium* Brid. has 80 species in the world, of which 6 species reported from Eastern Himalayas and South India are *Rh. canescens* (Hedw.) Brid., *Rh. fuscescens* Wils., *Rh. himalayanum* (Mitt.) Jaeg., *Rh. javanicum* Doz. et Molk., *Rh. lanuginosum* (Hedw.) Brid. and *Rh. sulcipilum* (C. Muell.) Par. So far there is no record of this genus from Western Himalayas. Two species of this genus have been collected for the first time from this region, from Garhwal District, near Badrinath, from an altitude of 4000 m. in October 1959, which have been identified as *Rh. canescens* and *Rh. himalayanum* and have also been confirmed from the authorities of British Museum (Nat. Hist.), London.

This genus is closely allied to *Grimmia* Ehrh. ex Hedw. by certain species but the present genus has many distinct characters of its own. The species of this genus have usually elongated dichotomous branches, which are often clothed with numerous short lateral branchlets. It also differs from *Grimmia* by long, narrow and nodulose basal cells, while in the latter they are neither so long nor nodulose, at the most sinuose.

In the present paper a detailed description of *Rh. canescens* and *Rh. himalayanum*, a key to the Himalayan taxa, duly represented also in Plate I and the distribution of the Indian species of *Rhacomitrium* are included.
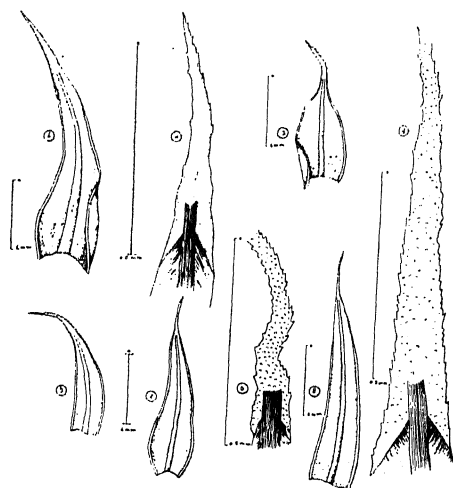
PLATE I (FIGS. 1–8). Figs. 1–2. The Leaf and its apical portion of *Rhacomitrium himalayanum* (Mitt.) Jaeg. Figs. 3–4. The Leaf and its hyaline apical portion of *Rh. canescens* (Hedw.) Brid. Figs. 5–6. The Leaf and its apical hyaline arista of *Rh. lanuginosum* (Hedw.) Brid. Fig. 7. Leaf of *Rh. fuscescens* Wils. Fig. 8. Leaf of *Rh. javanicum* Doz. et Molk.

Letters to the Editor

Key to the Himalayan Species

1 Arista hyaline, papillose   ..   2
    Arista hyaline, smooth   ..   3
2 Plants slender, leaves ovate-   *Rh. canescens*
    lanceolate, cells strongly
    papillose
    Plants robust, leaves lanceolate,   *Rh. lanuginosum*
    cells smooth
3 Leaves divergent, apex recurved,   *Rh. himalayanum*
    nerve strong
    Leaves not divergent, nerve   4
    not strong
4 Leaf base oval   ..   *Rh. fuscescens*
    Leaf base ovate   ..   *Rh. javanicum*

Rhacomitrium canescens (Hedw.) Brid., *Mant. Musc.*, 78, 1819, et *Bryol. Univ.*, 1 : 208, 1826 ; *Trichostomum canescens* Hedw., *Musc. Frond.*, 3 : 5, t. 3, 1823-24.

In lax tufts of bright yellowish-green colour. Stem erect or decumbent, 4-6 cm. tall, with numerous lateral branchlets. Leaves spreading, about 2 mm. long, on drying little changed, ovate-lanceolate, running into a strongly papillose hyaline arista, about half as long as leaf, more conspicuous in the upper leaves, margin entire, revolute ; nerve faint, pellucid ; basal areolations narrowly rectangular, $5\,\mu$ wide, nodulose, upper ones quadrate to sub-quadrate, $7\,\mu$ wide, sinuose, strongly papillose.

On forest humus, under shade of *Betula* trees. Satopant glacial bed, 3,500 m. *Vohra 53* (October 11, 1959).

Rhacomitrium himalayanum (Mitt.) Jaeg., *Ad.*, 1 : 375, 1872 ; *Grimmia himalayana* Mitt., *J. Linn. Soc. Bot. Suppl.* 1 : 45, 1859.

In loose yellowish-brown tufts. Stem stout, dichotomously branched, clothed with numerous short lateral branches. Leaves divergent, 2-3 mm. long, on drying somewhat appressed, apex reflexed, upper ones ending in a smooth hyaline arista, nearly half as long as the leaf, margin entire, ± (*i.e.*, more or less) recurved ; nerve strong, percurrent ; cells at base narrowly rectangular, $7\,\mu$ wide, strongly nodulose, incrassate, 1-2 rows at insertion brownish, upper cells sub-rectangular, $3 \cdot 5$-$5\,\mu$ wide, a few rows at margin quadrate, smooth.

On soil, alongside spring. Nar Parbat (near Badrinath), 4000 m. *Vohra 30.* (October 8, 1959).

DISTRIBUTION

The distribution of the Indian species of *Rhacomitrium* is given in Table I and from this the

following conclusion can be drawn. *Rh. fuscescens* is endemic to Sikkim, while *Rh. sulcipilum* is endemic to Coromandel Coast. *Rh. lanuginosum* is a cosmopolitan species, and *Rh. javanicum* has a common distribution in Palni Hills (S. India) and Eastern Himalayas and it appears as this species has spread from Java to both the sides. The new occurrence of *Rh. himalayanum* and *Rh. canescens* in Western Himalayas gives an indication of the spread of these species through Kumaon Himalayas from Eastern Himalayas.

TABLE I

Name of species	Western Himalayas	Eastern Himalayas and Sikkim	South India	Nepal and Bhutan
1	2	3	4	5
Rhacomitrium canescens	New Record	+*	..	..
Rh. fuscescens	..	+ (endemic)	..	..
Rh. himalayanum	New Record	+	..	+
Rh. javanicum	..	+	+	..
Rh. lanuginosum	−	+	+	+
Rh. sulcipilum	..	..	+ (endemic)	..

* '+' means present.

The authors are highly thankful to Dr. H. Santapau, Director, for his kind interest.

Botanical Survey of India,   B. M. WADHWA.
Central Circle,   J. N. VOHRA.
10-Chatham Lines,
Allahabad, *January* 1, 1965.

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2. Hedwig, J., *Species Muscorum Frondosorum*, Repr. Edit., Weinheim, 1960, pp. 1-353.

3. Mitten, W., *J. Proc. Linn. Soc. Bot. Suppl.*, **1859**, **1**, 1-157.

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REVIEWS AND NOTICES OF BOOKS

Simultaneous Rapid Combustion—*Microchemical Research Papers of Mirra Osipovna Korshun.* Edited by J. A. Kuck. Translated from the Russian by Phyllis L. Bolton and Kurt Gingold. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. xi + 560. Price $ 27.50.

M. O. Korshun was the founder of the Soviet school of quantitative organic microanalysis. She turned away from the old, classical methods of microanalysis and found a more rational method for the elemental analysis of organic compounds. Her methods are characterised by great precision and speed, together with simplicity and elegance. The purpose of the present book is to acquaint the English-speaking reader with the progress of quantitative organic microanalysis in Russia during the past two decades, as exemplified in the publications of Korshun and her successors. Considering the impact which her work has made both in the Soviet Union and abroad, this translation will undoubtedly be very welcome and attract the serious attention of organic chemists all the world over. It is warmly recommended.

C. V. R.

Infra-red Spectroscopy of High Polymers. By Rudolf Zbinden. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xii + 264. Price $ 9.50.

The purpose of this book is to assist both the spectroscopist in interpreting spectra of high polymers and the polymer scientist in using infra-red spectroscopy for the elucidation of chemical and physical structure of polymers. The book contains a discussion of methods and fundamentals, but is not a catalog of spectra.

Chapter I is a general survey of the subject while the remaining four chapters are more thorough treatments of some aspects of spectroscopy of high polymers. A guide to the literature and to sources of many spectra is contained in the appendix.

C. V. R.

Fluorine Chemistry (Vol. 5). Edited by J. H. Simons. (Academic Press, New York and London), 1964. Pp. xv + 505. Price $ 16.50.

The present volume continues the well-known series *Fluorine Chemistry*. The subject-matter is dealt with in four chapters whose titles and

their respective authors are given below: 1. General Chemistry of Fluorine-Containing Compounds, by J. H. Simons; 2. Physical Chemistry of Fluorocarbons, by T. M. Reed; 3. Radiochemistry and Radiation Chemistry of Fluorine, by John A. Wethington, Jr., and 4. Industrial and Utilitarian Aspects of Fluorine Chemistry, by H. G. Bryce.

Many utilitarian applications of fluorine-containing compounds have been found. Many of these are relatively new uses, but some of the well-known uses are increasing. In nuclear and radiation chemistry fluorine compounds have played a more important role than the compounds of any other electronegative element. There has been a large amount of activity in the general chemistry of the fluorides of all the elements of the periodic table. The fluorocarbons were originally created to provide substances for studies of molecular forces.

It will be evident from the foregoing that this volume will be warmly welcomed by a wide circle of readers.

C. V. R.

Methods in Cell Physiology (Vol. 1). Edited by David M. Prescott. (Academic Press, New York and London), 1964. Pp. xiii + 465. Price $ 16.50.

The editor has compiled in a single volume a wide variety of methods and techniques of general use to experimental biologists working on the physiology, biochemistry, and reproduction of the cell. Techniques are so fully described that they can be practically undertaken by cell biologists who have little or no experience in the particular area covered.

Volume 1 is devoted to culture methods and experimental procedures for a variety of cell types including amoeba, ciliates, mammalian tissues, culture cells, unicellular algae slime molds, and grasshopper neuroblasts. Autoradiography is thoroughly covered, including its applications to electron microscopy and quantitation.

C. V. R.

Cellular Membranes in Development. Edited by Michael Locke. (Academic Press, New York and London), 1964. Pp. xvi + 382. Price $ 12.00.

The structural similarity of all membranes has led to the unit membrane concept elaborated in this volume. The properties of bimolecular

phospholipid membranes are thoroughly discussed. Studies of membranes in a number of biological systems are described in detail. This volume will be of great value to cytologists, biochemists, physiologists, and molecular biologists.   C. V. R.

Experimental Chemotherapy, Vol. I. Edited by R. J. Schnitzer and Frank Hawking. (Academic Press, New York and London), 1963. Pp. xv + 1008. Price $ 38.00.

Experimental Chemotherapy, Vol. II. Edited by R. J. Schnitzer and Frank Hawking. (Academic Press, New York and London), 1964. Pp. xvii + 614. Price $ 23.00.

Experimental Chemotherapy, Vol. III. Edited by R. J. Schnitzer and Frank Hawking. (Academic Press, New York and London), 1964. Pp. xvii + 647. Price $ 25.00.

Experimental Chemotherapy is a treatise in four volumes of which the first three volumes have so far appeared. Volume I is devoted to the chemotherapy of protozoan and metazoan infections. Each chapter, written by an authority in his particular field, describes drug activity and its mechanism in correlation with the basic biological properties of the various parasites, the host-parasite relationship, and the influence of chemical structure on action. Also included are the toxicology of commercial and experimental compounds, and the technical procedures of drug testing and their evaluation. The book contains a penetrating analysis of the similarities and differences of experimental findings and the clinical activity in human and veterinary medicine. General aspects, such as the history of chemotherapy, toxicological principles, and statistical operations are presented in the introductory chapters.

Volume II presents a series of discussions on the broad field of chemotherapy of bacterial infections. Featured are the chemistry, antimicrobial action, and toxicology of antibacterial agents. After an introductory chapter by C. H. Browning, Paul Ehrlich's co-worker, describing the early history of antibacterial therapy with dye-stuffs, the contributing authors, all specialists in their fields, discuss the various groups of active compounds on the basis of their own experimental work.

Volume III of this treatise completes the description of the chemotherapy of infectious diseases. It contains the second part of the section on bacterial infections, which is devoted to the antibacterial substances of natural origin (antibiotics), and it deals further with fungal,

rickettsial, and viral infections. The authors of the individual chapters have in all instances stressed the mode of action of the effective agents and the experimental approaches to the complex problems involved, thus emphasizing the general principles of chemotherapeutic activity. To keep the work within reasonable bounds, it has been necessary to limit consideration mainly to substances which have been discovered in recent years or which are of special interest on account of new developments in their theoretical interpretation or practical potentialities.

In view of what has been stated, it is evident that the treatise will serve not only as a source of information for the experimenter in the field of chemotherapy but also for everybody who, as a teacher, a researcher, a practising physician, or a veterinarian, is concerned with the subject.
                                            C. V. R.

International Review of Cytology. Edited by G. H. Bourne and J. F. Danielli. (Academic Press, Inc., 111, Fifth Avenue, New York.) Volume 16 : 1964. Pp. 345. Price $ 14.00 ; Volume 17 : 1964. Pp. 401. Price $ 16.00.

Volume 16 of this well-known series contains the following articles : (*i*) Ribosomal Functions Related to Protein Synthesis, by Tore Hultin : (*ii*) Physiology and Cytology of Chloroplast Formation and "Loss" in Euglena, by M. Grenson ; (*iii*) Cell Structures and Their Significance for Ameboid Movement, by K. E. Wohlfarth-Bottermann ; (*iv*) Microbeam and Partial Cell Irradiation, by C. L. Smith : (*v*) Nuclear-Cytoplasmic Interaction with Ionizing Radiation, by M. A. Lessler ; (*vi*) In Vivo Studies of Myelinated Nerve Fibres, by Carl Caskey Speidel and (*vii*) Respiratory Tissue : Structure, Histophysiology, Cytodynamics, Part I. Review and Basic Cytomorphology, by Felix D. Bertalanffy.

Volume 17 contains the following articles : (*i*) The Growth of Plant Cell Walls, by K. Wilson ; (*ii*) Reproduction and Heredity in Trypanosomes, by P. J. Walker ; (*iii*) The Blood Platelet : Electron Microscopic Studies, by J. F. David-Ferreira ; (*iv*) The Histochemistry of Mucopolysaccharides, by Robert C. Curran : (*v*) Respiratory Tissue : Structure, Histophysiology, Cytodynamics, Part II. New Approaches and Interpretations, by Felix D. Bertalanffy and (*vi*) The Cells of the Adenohypophysis and Their Functional Significance, by Marc Herlant.
                                            C. V. R.

Advances in Applied Mechanics (Vols. I and II) —*Rarefied Gas Dynamics*. Edited by J. A. Laurmann. (Academic Press, New York), 1963. Vol. I : Pp. xvi + 529 ; Vol. II : Pp. xvi + 541. Price $ 16.00 each.

These two volumes contain a full report of the 3rd International Rarefied Gas Dynamics Symposium, held at Paris in 1962 for which representatives from throughout the world gathered. The Proceedings cover a range of subjects of interest to both the fundamental researcher and the applied scientist working in high altitude aerodynamics and low density flows. Included are studies in the foundations of kinetic theory as applied to low density flow of both ionized and unionized gases, molecular beam and gas-surface interaction investigations, and theory and experiment in the transition regime between free molecule and continuum flow. These volumes offer the reader reports on important specific advances, as well as an overall view of the current state of knowledge in the field.

Volume I is divided into two sections, *viz.*, 1. Fundamental Kinetic Theory and Solutions of the Boltzmann Equation and 2. Molecular Beams and Surface Interactions. Section 1 contains 16 papers and Section 2 contains 12 papers by specialists in the field.

Volume II is divided into four sections, *viz.*, 1. Ionized Gas Flows ; 2. Transition Flow— Theory ; 3. Transition Flow—Experiment and 4. Experimental Methods in Rarefied Gas Flows. Each section contains papers ranging from five to ten by specialists in the field.   C. V. R.

Blood Vessels and Lymphatics. Edited by David I. Abramson. (Academic Press, New York and London), 1962. Pp. xx + 812. Price $ 26.00.

This work assembles current data on the embryology, anatomy, physiology, pharmacology, biochemistry, and pathology of arteries and arterioles, veins and venules, and lymphatics. Promising but still unproven viewpoints, as well as orthodox concepts, are emphasized and attention is focused on gaps in knowledge of the field, for the purpose of stimulating interest in the exploration of new areas of research. Fifty-two scientists have contributed sections devoted to their particular areas of research. These sections have been integrated into a systematic and co-ordinated work covering the subject comprehensively. An extensive bibliography is appended to each chapter.

This volume will be of value to the research worker, the advanced student in the field, and the specialist seeking background knowledge and sources of information in areas related to the subject of his immediate concern.

    C. V. R.

Advances in Biological and Medical Physics, Vol. VIII. Edited by Cornelius A. Tobias and John H. Lawrence. (Academic Press, New York and London), 1962. Pp. ix + 457. Price $ 15.

Volume VIII of this well-known series contains the following eight important articles and the names of their respective authors are shown against each : 1. Chemical Elements of the Blood of Man in Health, by John W. Gofman ; 2. Neutron Activation Analysis, by Kwan Hsu ; 3. Low level Gamma-Ray Scintillation Spectrometry : Experimental Requirements and Biomedical Applications, by L. D. Marinelli, C. E. Miller, H. A. May and J. E. Rose ; 4. Heavy Ions and Some Aspects of Their Use in Molecular and Cellular Radiobiology, by Tor Brustad ; 5. Hypothalamus and Thyroid, by P. Blanquet (with the collaboration of J. Faure) ; 6. The Origin of Life on Earth and Elsewhere, by Melvin Calvin ; 7. The Physics of Space Radiation, by Roger Wallace ; and 8. Mechanisms of Carcinogenesis, by Niels Arley and Reidar Eker.   C. V. R.

Non-linear Wave Propagation with Applications to Physics and Magnetohydrodynamics. By A. Jeffrey and T. Taniuti. (Academic Press, New York and London), 1963). Pp. 369. Price $ 12.00.

The book under review has been published as Volume 9 in the series *Mathematics in Science and Engineering*, under the general editorship of Richard Bellman.

The book is in two parts. Part I deals with the general theory of non-linear wave propagation in three chapters : General Hyperbolic Equations, The Method of Characteristics, and Conservation Laws and Weak Solutions. Part II is devoted to the discussion of non-linear wave phenomena in Magnetohydrodynamics, under the headings : The Fundamental Equations and Characteristics, Simple Waves, Magnetohydrodynamics, Shocks, Interaction of Hydromagnetic Waves, and Spatial Discontinuities.

The extensive discussion of the non-linear wave propagation in magnetohydrodynamics leads in a systematic manner to the present-day knowledge of the subject.

The portions dealing with general conservation laws, generalized Riemann invariants, weak solutions and evolutionary conditions on discontinuities in conservation laws of hyperbolic type have been written with great competence and explain the rather difficult ideas in a lucid manner.

The book also contains six useful appendices to supplement the textual matter.

The reviewer has great pleasure in recommending this book to research workers and post-graduate students in this field.

<div align="right">P. L. B.</div>

Strength and Deformation in Non-Uniform Temperature Fields. Edited by Prof. Ya. B. Fridman. [Consultant Bureau Publications of Current Russian Scientific Literature (Authorized Translations from the Russian), Consultants Bureau Enterprises, Inc., 227 W, 17th Street, New York.] Pp. 169. Price $ 25.00.

This monograph contains the following five articles : (1) Some of the laws governing the mechanical and thermal strength, by Ya. B. Fridman ; (2) Thermal stresses and their calculation, by E. M. Morozov and Ya. B. Fridman ; (3) Thermal fatigue and thermal shock, by N. D. Sobolev and V. I. Egorov ; (4) Fundamentals of creep calculations on non-uniformly heated parts, by B. F. Shorr ; (5) Thermal stability of plates and shells, by L. A. Shapovalov.

Each article is a critical review of recent papers that have appeared on the subject and to which references have been given. There is no question about the importance of the problems dealt with, and this collection of papers is sure to be of interest to investigators in various branches of engineering.

Structure Formation in Alloys. By Il'ya Vasil'evich Salli. [Consultants Bureau Publications of Current Russian Scientific Literature (Authorized Translations from the Russian), Consultants Bureau Enterprises, Inc., 227 W, 17th Street, New York.] Pp. 140. Price $ 18.50.

This monograph presents the mechanism of the formation of the structure of alloys from the viewpoint of the modern theory of phase transformations. In the nine chapters the author deals with topics such as conditions determining the creation of the different phases in alloys, formations of crystals of different compositions and dispersities, causes of metastability of alloys, transformation of metastable systems into the stable state, etc.

Intensity Theory for Infra-red Spectra of Polyatomic Molecules. By Lev Aleksandrovich Gribov. [Consultants Bureau Publications of Current Russian Scientific Literature (Authorized Translations from the Russian), Consultants Bureau Enterprises, Inc., 227 W, 17th Street, New York.] Pp. 113. Price $ 15.

The treatment which is essentially mathematical develops in a logical manner the presently accepted semi-empirical theory of the intensities and polarizations in the infra-red spectra of polyatomic molecules and its applications to study molecular structures. With all its limitations the theory has helped to form basic concepts and useful generalisations towards understanding infra-red absorption bands, and hence this publication will be specially useful to workers engaged in spectrochemical studies.

Soviet Researches on Luminescence. Edited by Acad. D. V. Skobel'tsyn. [Consultants Bureau Publications of Current Russian Scientific Literature (Authorized Translations from the Russian), Consultants Bureau Enterprises, Inc., 227 W, 17th Street, New York.] Pp. 152. Price $ 27.

This is an authorized translation from the Russian original published by the USSR Academy of Science as Volume XXIII of the Transaction (Trudy) of the P. N. Lebedev Physics Institute. The monograph gives an account of the recent investigations carried out by workers of the Institute on Electroluminescence and Cathodoluminescence. A subtle distinction is made between the two types of luminescence according as the radiating body receives energy directly from the electric field or from extraneous electrons. The investigations are chiefly concerned with zinc sulphide and related cathodoluminophors.

<div align="right">A. S. G.</div>

Chemistry of Lac. By P. K. Bose, Y. Sankaranarayanan and S. C. Sen Gupta. (Published by Indian Lac Research Institute, Namkum, Ranchi, Bihar, India), 1963. Pp. 225. Price Rs. 20·40.

The authors have brought out in this volume all important information available on the chemical aspects of lac. The systematic treatment includes chapters on the physical and chemical properties of shellac, constituents of the different types of lac and lac resin, aleuritic and shellolic acids, structure of lac molecule, minor constituents, polymerization of shellac,

miscellaneous treatments of shellac and practical applications.

The information compiled in this volume will be of use to workers in lac research.

<div align="right">A. S. G.</div>

Thermal Radiative Properties. By W. D. Wood, H. W. Deem and C. F. Lucks. (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964. Pp. 470. Price $ 17.50.

Modern space and missile technology has brought new materials and alloys into use. This has created a need for specific data on their thermal properties, especially in the high-temperature range. The present volume, the third in the series *Handbook of High-Temperature Materials* is on Thermal Radiation Properties, and contains thermal radiative data for the following materials : Titanium and its alloys, Stainless steels, Iron-, Nickel-, and Cobalt-base super alloys, coated materials, ceramics and graphite. The presentation throughout is in the form of curves which indicate the most probable values for the various conditions and materials. <div align="right">A. S. G.</div>

Space-Age Acronyms Abbreviations and Designations. By Reta C. Moser. (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964. Pp. 427. Price $ 17.50.

An acronym is a word formed from the initial letters of other words. Some acronyms are pronounceable, but a vast many are not. The modern tendency of subject-centred specialization in science, engineering and technology has created a new vocabulary of acronyms. While an acronym is an inevitable nuisance not to know it when you are faced with one is worse. The reviewer did not realise the magnitude of this verbal invasion into our scientific terminology till he saw the present publication of 427 pages containing space acronyms whose number is of the order 10^4.

As Humpty Dumpty said, "When I make a word do a lot of work like that, I always pay it extra". This SAAAD is heartily recommended to space scientists and space science readers.

<div align="right">A. S. G.</div>

Books Received

Exploding Wires (Vol. 3). Edited by W. G. Chace and H. K. Moore. (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964. Pp. 410. Price : $ 17.50.

Biological Effects of Magnetic Fields. Edited by M. F. Barnothy (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964, Pp. ix + 324. Price $ 16.00.

Space-Age Acronyms. By R. C. Moser. (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964. Pp. 427. Price $ 17.50.

Methods of Silicate Analysis (2nd Edition). By H. Bennett and W. G. Hawley. (Academic Press, Inc., London W. 1), 1963. Pp. xv + 334. Price 63 *sh.*

The Proteins—Composition, Structure and Function, Vol. 3 (2nd Edition). Edited by Hans Neurath. (Academic Press, Inc., New York), 1965. Pp. x + 585. Price $ 21.00.

Advances in Geophysics (Vol. 10). Edited by H. E. Landsberg and J. Van Mieghem. (Academic Press, Inc., New York), 1964. Pp. xi + 488. Price $ 16.50.

International Review of General and Experimental Zoology (Vol. 1). Edited by W. J. L. Felts and R. J. Harrison. (Academic Press, Inc., New York), 1965. Pp. xi + 445. Price $ 14.50.

Advances in Food Research (Vol. 13). Edited by C. O. Chichester, E. M. Mrak and G. F. Stewart. (Academic Press, Inc., New York), 1964. Pp. viii + 401. Price $ 14.50.

Nutrition—A Comprehensive Treatise (Vol. II)— *Vitamins Nutrient Requirements and Food Selection.* (Academic Press, Inc., New York), 1964. Pp. xiv + 551. Price $ 18.50.

Proteins and Related Subjects (Vol. 12)— *Protides of Biological Fluids.* Edited by H. Peeters. (Elsevier Pub. Co., Ltd., 12 B, Ripple Side Commercial Estate, Ripple Road, Barking, Essex), 1965. Pp. xi + 482. Price 120 *sh.*

Science of Ceramics (Vol. 2). Edited by G. H. Stewart. (Academic Press, Inc., London W. 1), 1965. Pp. 431. Price 84 *sh.*

Essential of Electricity and Magnetism. By O. M. White. (Macmillan, St. Martin's Street, London W.C. 2), 1965. Pp. ix + 320. Price 20 *sh.*

Essentials of Heat. By O. M. White. (Macmillan, St. Martin's Street, London W.C. 2), 1965. Pp. viii + 211. Price 15 *sh.*

Plenum Press Hand Books of High Temperature Materials (No. 3)—*Thermal Radiative Properties.* By W. D. Wood, H. W. Deem and C. F. Lucks. (Plenum Press, 227, West 17th Street, New York, N.Y. 10011), 1964. Pp. 470. Price $ 17.50.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Nuclear Physics to Sri. A. Ramalinga Reddy for his thesis entitled "Studies on Incoherent Scattering of Gamma Rays by K-Shell Electrons"; Ph.D. degree in Chemistry to Sri. D. Satyasundar for his thesis entitled "Studies on the Solvent Extraction of the Blue Perchromic Acid"; Ph.D. degree in Pharmacy to Sri. R. V. Krishna Rao for his thesis entitled "Chemical Investigation of Some Medicinal Plants and Other Poisonous Plants of India"; Ph.D. degree in Zoology to Sri. T. Desiraju for his thesis entitled "Experimental Studies on a Sympathetic Ganglion and on Brain".

Osmania University has awarded the Ph.D. degree in Zoology to Sri. P. Sudershan for his thesis entitled "Studies on Joint Action of Insecticides and Synergists on Cockroach Heart".

Sri Venkateswara University has awarded the Ph.D. degree in Zoology to Sri. R. P. Sreenivasa Reddy for his thesis entitled "Biology of the Scorpions with Special Reference to the Pectines".

Indian Council of Medical Research—Supernumerary Research Cadre

The Indian Council of Medical Research has decided to constitute a Supernumerary Research Cadre to provide for research workers—both medical as well as non-medical—who return to India after completing their training abroad and to enable them to pursue research in the speciality in which they had received training. Selection to the Cadre will be made by a Committee appointed by the Governing Body, I.C.M.R. This Committee will also recommend suitable emoluments commensurate with the candidate's qualifications and research experience. Persons selected for the Cadre will be entitled to emoluments ranging from Rs. 500 to Rs. 1,000 p.m. Contingent grant of Rs. 3,000 per annum and some equipment will be provided to each research worker.

Further enquiries and applications may be sent to The Director, Indian Council of Medical Research, Ansari Nagar, New Delhi.

Grouping of "Elementary" Particles—SU(6) Symmetry

An important starting-point in the investigation of a physical system is the determination of the symmetries it possesses. Once these are known, many of the system's properties can be established by quite general means. The mathematical description of a symmetry is in terms of a corresponding set of operations that leaves the system unchanged. By this we mean the result of these operations still gives the same system although perhaps in a different state.

With the multiplicity of "elementary" particles whose existence has been experimentally established, the idea is gaining ground that they can be grouped into a few large families or "supermultiplets" within each of which the particles can be regarded as mathematical equivalents of one another. Present schemes for grouping of elementary particles and their reactions are based on the unitary symmetry theory called SU(3). Within the past few months a still more comprehensive ordering scheme called SU(6) has won broad support among theoretical nuclear physicists.

The SU(3) theory showed how particles that vary in certain basic properties (isotopic spin and hypercharge) can be regarded as members of a supermultiplet, provided they are alike in other basic properties (ordinary spin and parity). The most familiar particles that can be grouped in this way are the nuclear doublet (the neutron and proton), three sigma particles, two xi particles and a lambda particle. These constitute an octet supermultiplet with 8 members. A decuplet supermultiplet with 10 members which also fulfilled SU(3) requirements was lacking its tenth member at the time it was proposed. When this missing particle, the Omega *minus*, was discovered last year, it signalled a triumph for the SU(3) symmetry.

The new SU(6) theory is based on Wigner's suggestion, made some 30 years ago, that the forces inside the atomic nucleus might be largely independent of the spin of the nuclear components. The 8-member and 10-member supermultiplets of SU(3) are characterized by different amounts of spin angular momentum. Particles in the 8-member group have 1/2 unit of spin, while those in the 10-member group have 3/2 units of spin. In the SU(6) theory the spin itself is regarded as a secondary property, like charge, hypercharge, isotopic spin and mass. Thus in the SU(6) system the octet

and decuplet form a supermultiplet not of 18 members but of 56. This follows from the fact that each particle in the octet has two spin states thus giving rise to 16 states, and each particle in the decuplet has four spin states for a total of 40 states. According to the extended symmetry SU(6) the 56 members of the supermultiplet can transform into each other.

One unexpected triumph of SU(6) is that it accounts for the ratio of the magnetic moment of the neutron to that of the proton, which is $1.91/2.79$ or $-.68$. According to SU(6) it should be $-2/3$ or $-.67$.—(*Sci. Amer.*, March 1965.)

Oldest Rocks : A Revision of the Age of the Earth ?

Analysis of the relative abundance of strontium isotopes in samples of rock from a group of islets halfway between South America and Africa indicates that the rock may be 4·5 billion years old, about a billion years older than any heretofore studied. The rocks nearest in antiquity are a South African granite with an isotope age of 3·2 billion years and a Minnesota granite with an age of 3·3 to 3·5 billion years.

The islets known as St. Peters and St. Paul Rocks lie on the mid-Atlantic ridge near the equator. They have long interested geologists because they are composed entirely of peridotite. In theory peridotite is a major component of the outer mantle. It has been speculated that the islets are surface exposures of this primordial layer.

Five peridotite samples from the region were analyzed during the last year by the isotope geology group of the Carnegie Institution of Washington to determine Sr^{87} (the decay product of Rb)/Sr^{86} ratio in their contents. One sample substantially exceeded the other four both in the proportion of Sr^{87} and in the quantity of undecayed rubidium present. The results indicate that it is not a product of the normal oceanic rock generation process, but it is possible that the sample is a fragment of outer mantle chemically unaltered from its time of formation 4·5 billion years ago.

Further evidence for a revision of the accepted age of the earth has also come from certain lead isotope analysis in feldspars and galenas of different ages on the North American continent. These investigations by the same group suggest a minimum age of 4·7 billion years for the earth.—(see *Carnegie Institution Year Book*, 1963.)

Site for the Mohole

After a six-year search for the ideal spot at which to drill a hole through the earth's crust to the underlying mantle, earth scientists have selected a site in the Pacific Ocean 100 miles north of Hawaii. At the chosen site the sea is some 14,000 ft. deep and the ocean floor is an estimated 17,000 ft. above the mantle, so that the surface-to-mantle distance is a relatively short six miles.—(*Sci. Amer.*, March 1965.)

Molecular Oxygen in the Venus Atmosphere

The detection of molecular oxygen in the atmosphere of Venus would be of great interest. The presence of this gas, if elementary to the atmosphere, might be indicative of the geological and perhaps biological history of the planet. However, spectroscopic investigations have, to date, shown unambiguously only the presence of carbon dioxide.

Spectroscopic method of estimating the molecular oxygen content of the Venus atmosphere consists in measuring the Doppler shift of the O_2 lines from Venus atmosphere with respect to the telluric O_2 lines. Using the 48-inch reflector of the Dominion Astrophysical Observatory, Ottawa, Canada, and with improved Doppler-shift technique and curve of growth analysis, H. Spinrad and E. H. Richardson have reported their determination of the upper limit to the O_2 content of the visible Venus atmosphere. Spectrograms were taken for range of Venus velocity from -13 to $+13$ km./sec. Measurements lead to a limit of 57 cm.-atm. O_2, less than the terrestrial abundance by a factor of 2,800. Relative abundance of O_2 in Venus atmosphere is $< 8 \times 10^{-5}$, for Earth it is 0·23.

The terrestrial O_2 is produced by photosynthetic activity of present-day plants and through photo-dissociation of H_2O. The lack of molecular oxygen in the Venus atmosphere probably means that the process of plant photosynthesis and the dissociation of H_2O are negligible.—(*Astrophys. Jour.*, 1965, 141, 282.)

THE NEW PHYSIOLOGY OF VISION

Chapter XVIII. The Visual Synthesis of Colour

Sir C. V. RAMAN

IN the preceding chapters, we have been principally concerned with monochromatic light and the sensations excited by it. But in most cases of practical interest, the light which reaches the eye of an observer and enables him to perceive the objects around him is not monochromatic but is composite in character. As a consequence, the visual sensations result from the superposition of light appearing in various parts of the spectrum. The spectral nature of the light emitted by the original source and the optical properties of the objects on which it falls and from which it reaches the eyes of the observer determine its character. Hence, what the eye perceives is the integrated effect of light distributed over the visible spectrum, and a process which may be called the visual synthesis of colour is involved in the perception. This is evidently a subject which is highly important both from a practical point of view and from the standpoint of physiological theory. It will receive detailed consideration in this and the following chapters.

From the nature of the subject, it is evident that our understanding of it has to be based on the actual facts of experience in various cases, these being sufficiently numerous and representative to enable valid inferences to be drawn therefrom. What we wish to ascertain is the general nature of the relationship between the perceived colour and the spectral composition of the light which reaches the eyes of the observer. The latter can, of course, exhibit a wide range of variations and the question arises how it should be ascertained and specified. The further question arises how the perceived colour is to be characterised and described. The problems here stated indicate the complexity of the subject. The choice of the material utilized for such studies is evidently a matter of importance. It should be such as to minimise the difficulties of the investigation.

In the present chapter, we shall set out the results emerging from a study of the visual synthesis of colour made with material which is in a particularly suitable and convenient form, viz., colour filters which absorb a limited part of the spectrum more or less completely and freely transmit the rest of it. It will be recalled that a great many filters of gelatine-on-glass dyed with suitable colouring matters were specially fabricated and made use of for the studies described in earlier chapters. Such filters have been utilised also in the present studies. Colour filters can also be prepared by dissolving a small quantity of a dye-stuff or other material in distilled water contained in a rectangular glass cell of suitable dimensions (10 cm. × 10 cm. × 2 cm.). By varying the quantity of the absorbing material put in, its effective thickness can be varied and the resulting changes in the colour and the spectral nature of the transmitted light can be conveniently followed.

Colour Filters of Cyanin.—We shall now describe in detail, the observations made with a set of seven filters of gelatine-on-glass coloured by the well-known dye-stuff cyanin to different extents and thus exhibiting the effect in a regular sequence of an increasing measure of absorption, both on the colour of the transmitted light and on its spectral character.

To study the character of the spectrum of the light transmitted by a filter, a convenient plan is for the observer to hold a replica diffraction grating in front of his eye and to view the first-order diffraction spectrum of linear tungsten filament in a tubular lamp glowing at a white heat. Introducing the filter in front of the diffraction grating, the change in the spectrum produced thereby can be quickly noted. It then becomes evident that absorption by the cyanin filters is limited to the yellow, orange and red sectors of the spectrum, while the blue and the green sectors are transmitted without any noticeable loss of intensity. The absorption in the red sector takes the form of a well-defined absorption band, which in the case of the weakest filter may be located in the wavelength range 620 mμ. In the other filters of the series, this band becomes more pronounced and also becomes wider, the spreading being asymmetrical and chiefly towards the lesser wavelengths. Even through the most heavily dyed filter, the red end of the spectrum in the region of 700 mμ continues to be freely transmitted.

Simultaneously with the increase of the absorption in the red, the absorption in the yellow

and orange becomes intensified, until finally with the most heavily dyed filter, we have a continuous absorption commencing at 570 mμ covering the yellow and orange sectors and joining up with the absorption band in the red mentioned above. It is noteworthy that even within the most heavily dyed filter, there is no observable absorption in the region of wavelengths less than 570 mμ. In particular, the green of the spectrum comes through with full intensity.

The colour of the light transmitted by the filters as seen by holding them against a clouded sky may be described as blue in all cases. There is, however, an observable progression which can be described as an increase in the depth of the colour or alternatively as an increase in the degree of its fullness or saturation. These changes, it should be remarked, go hand in hand with the increase in the absorption in the yellow sector of the spectrum between 570 mμ and 590 mμ. Indeed, it would be correct to say that the blue colour of the light transmitted by the filters exhibits fullness or saturation to an extent determined by the completeness of the absorption of the yellow.

With the disappearance of the yellow sector of the spectrum, and the extinction of the greater part of the red sector, we are still left with the blue and green sectors which are present in full strength. It is remarkable that there is scarcely any indication in the perceived colour of the green sector which is seen with great intensity in the spectrum of the light which passes through the filter.

The Cuprammonium Filter.—Dissolving copper sulphate in distilled water and adding ammonia in excess, we obtain a solution exhibiting a characteristic blue colour. When the concentration of the solution is high, the transmission by it is confined to the region of the shortest wavelengths and, indeed, the cuprammonium filter is usually employed for isolating this part of the spectrum. When, however, the solution contained in a cell two centimetres thick is progressively diluted by addition of distilled water, striking changes may be observed in the spectrum of the light transmitted by it. The transmission, which at first is confined to the violet end of the spectrum, extends towards longer wavelengths. It ceases to be confined to the blue regions of the spectrum and the green sector is also transmitted. This progressively gains in strength until as seen through the spectroscope, the green actually appears more luminous than the blue sector.

With further dilution, the transmission extends into the orange and the red of the spectrum, but the yellow region remains faint, the orange and the red much exceeding it in brightness. Throughout this series of changes, the colour of the transmitted light is perceived as blue, the depth or saturation of the colour diminishing notably in the case of the very dilute solutions. The observations thus make it evident that the blue colour of the transmitted light and the extinction of the yellow in its spectrum are connected phenomena.

Solutions of Potassium Dichromate.—Commencing with a concentrated aqueous solution of potassium dichromate and progressively diluting it with distilled water, we can readily follow the changes in the perceived colour of the light transmitted through a definite thickness of the solution in relation to its spectral character. The concentrated solution is of a deep orange hue and the spectrum exhibits a cut-off of all wavelengths less than 565 mμ. A considerable measure of dilution is needed before there is any marked change of colour or a noticeable shift in the position of the cut-off. Step by step, however, these changes may be effected and as the cut-off moves from 565 mμ to 520 mμ the colour alters progressively from a deep orange to a rich golden-yellow. On further dilution, the cut-off becomes less sharply defined and moves from the green into the blue sector of the spectrum. The colour then alters to a bright yellow and then to paler and paler shades of yellow. So long, however, as even a tinge of yellow is observable in the colour of the transmitted light, the absorption at the short-wave end of the spectrum continues to be noticeable.

Solutions of Cobalt Sulphate.—An absorption of light in the green of the spectrum covering the wavelength range between 500 mμ and 550 mμ coupled with a free transmission of the longer wavelengths is manifested by moderately strong aqueous solutions of cobalt sulphate. Stronger solutions exhibit an absorption extending to about 575 mμ and appear of a deep orange colour by transmitted light, while weak solutions exhibit a colour varying from a rose-red to an orange-red depending on the extent of dilution. There is an observable transmission through the solutions of the shorter wavelengths in the spectrum. But such transmission does not appear to have any marked effect on the colour of the transmitted light.

Solutions of Nickel Chloride.—Aqueous solutions of this crystalline salt exhibit notable

variations in the brightness and colour of the transmitted light as the concentration of the salt is varied. These changes are most conveniently exhibited by filling a set of bottles of the same size with solutions of different concentrations and placing them side by side against the same white background so that their differences in appearance are evident at a glance. The relationship of the colour to the spectral character of the light transmitted through the solution can also be followed with the aid of a pocket spectroscope.

The green colour of solutions of nickel chloride is a consequence of an absorption of light which manifests itself at both ends of the spectrum, the intermediate parts being freely transmitted. When solutions of different concentrations are set side by side and compared with each other, it is found that a very striking change occurs when the cut-off of the longer waves shifts its position from about 570 mμ to 590 mμ. In the former case, the yellow of the spectrum is completely cut off, while in the latter case it is freely transmitted. As a result, the transmitted light notably gains in intensity and its colour changes from a clear green to a green tinged with yellow. Greater dilutions in which the cut-off shifts further into the red result in less noteworthy changes. The highly important role played by the yellow sector of the spectrum in determining the colour of the transmitted light is thus made apparent.

Solutions of Chromium Chloride.—Strong solutions of the chloride of chromium exhibit a deep green colour which owes its origin to a transmission in the 500 mμ–550 mμ region of the spectrum. Holding up a cell containing such a solution against a strong light and examining the light coming through it with a pocket spectroscope, the transmission band in the green sector is found to be accompanied by another located near the red end of the spectrum. It is the intermediate region containing the yellow of the spectrum which is most strongly absorbed. Dilution by successive additions of distilled water results in a large increase in the brightness of light transmitted by the cell, but there is no very pronounced change in its colour. Spectroscopic examination in these circumstances reveals that the band of transmission in the green has broadened in either direction and that the red sector has also made its appearance in the transmitted light. When the dilution has been carried far enough, the red region of the spectrum is quite conspicuous and it is only a little less bright than it is normally.

It seems surprising that in the circumstances stated above, the colour of the transmitted light is not very different for the dilute solutions and for the stronger ones. The explanation for this feature is chiefly that in neither case does the yellow sector of the spectrum in the range of wavelengths between 570 mμ and 590 mμ appear in the transmitted light. Indeed, the bands of transmission in the green and in the red come close to each other but the intervening yellow is scarcely visible. In the absence of the yellow sector, the transmission of the red sector has but little influence on the perceived colour. The only perceivable change is a diminution in the fulness or degree of saturation of the colour.

That the green solutions of chromium chloride powerfully absorb the yellow sector of the spectrum is strikingly illustrated by viewing a brightly illuminated screen through a cell containing such a solution and then suddenly removing the cell. The fovea of the observer's retina is then conspicuously visible projected on the screen as a bright yellow disk.

Solutions of Methyl Violet.—Using a glass cell two centimetres deep containing distilled water, and adding to it drop by drop a strong solution of the well-known dye-stuff methyl violet, the changes resulting therefrom in the perceived colour of the transmitted light and their relation to the changes in its spectral character can both be followed step by step. The first noticeable change in the spectrum of the transmitted light is the manifestation of a powerful absorption in the wavelength range from 570 mμ to 600 mμ. This becomes more and more pronounced and finally quite complete. Accompanying this change and evidently as the result of it, the transmitted light assumes a reddish-purple colour and this develops into a fully saturated hue. On further addition of the methyl violet, the absorption of the yellow extends into the orange up to about 620 mμ. A weak and rather ill-defined absorption also appears in the spectral range between 520 mμ and 570 mμ. This ultimately joins up with the absorption in the yellow and orange and forms a continuous band of extinction extending from about 520 mμ to 620 mμ. The final colour of the transmitted light is a reddish-purple, not noticeably different from that exhibited when the absorption of the green is weak and just noticeable.

The facts of observations stated above clearly indicate that it is the absorption of the yellow in the spectrum by the dye-stuff which results

in the manifestation of a reddish-purple colour by its solution.

Solutions of Crystal-Violet.—Following the same procedure as that described above for the case of methyl-violet, the behaviour of solutions of the closely related dye-stuff crystal-violet can be studied. The detailed description of the observed effects given above may be repeated almost *verbatim,* except for the following differences. The strong absorption which first manifests itself now extends from 580 mμ to 610 mμ instead of from 570 mμ to 600 mμ as in the case of methyl-violet and the colour of the transmitted light is a bluish-purple instead of a reddish-purple. The extinction band which is seen when a sufficient quantity of the dye-stuff has been added to the solution now extends from 530 mμ to 630 mμ, and the colour of the transmitted light at this stage remains a bluish-purple.

Thus, the facts indicate that it is the absorption of the yellow in the spectrum by the dye-stuff which results in the manifestation of a bluish-purple colour by its solutions. That methyl-violet yields reddish-purple solutions while crystal-violet yields solutions of a bluish-purple colour becomes intelligible when it is mentioned that the brightness of the red sector relatively to the blue sector as perceived in the spectrum of the transmitted light is manifestly greater for methyl-violet than for crystal-violet.

Solutions of Bromo-Cresol Purple.—An intense absorption of the yellow in the spectrum is a characteristic property of aqueous solutions of this dye-stuff. Dilute solutions of it exhibit a purple colour and spectroscopic examination of the transmitted light reveals that this is a consequence of the powerful absorption manifesting it as a dark band in the spectrum covering the spectral range from 570 mμ to 610 mμ, while there is no noticeable absorption of either shorter or longer wavelengths. With further addition of the dye-stuff to the solution, the absorption band spreads in either direction, and covers the spectral range from 550 mμ to 620 mμ. No noticeable change in the colour of the transmitted light however results therefrom.

Solutions of Bromo-Phenol Blue.—Dilute solutions of this dye-stuff exhibit a light bluish-purple colour associated with an intense absorption covering the spectral range from 580 mμ to 610 mμ and perfect transparency to the rest of the spectrum. Less dilute solutions exhibit a somewhat deeper purple colour coupled with an absorption covering the spectral range from 550 mμ to 620 mμ.

Solution of Chloro-Phenol Red.—Dilute solutions of this dye-stuff exhibit a powerful absorption in the wavelength range 560 mμ to 590 mμ which appears as a dark band in the spectrum. The colour of the solution as exhibited by a layer two centimetres thick is a purplish-red. Less dilute solutions exhibit an absorption band covering the wider spectral range from 540 mμ to 600 mμ and the same colour but somewhat more pronounced. There is also a distinct general absorption of the blue and the green in the spectrum and consequent weakening of those regions. This is evident on a comparison with the red part of the spectrum.

Solutions of Coomassie Violet.—When a few drops of a solution of this dye-stuff are put into a cell containing distilled water, the spectrum of the transmitted light exhibits a weak absorption in the wavelength range between 500 mμ and 560 mμ, in other words of the green sector in the spectrum. Further additions increase the strength of this absorption till it becomes complete and appears as a dark band crossing the spectrum. There is, however, no noticeable spreading out of the band, nor is there any noticeable absorption in the other parts of the visible spectrum. The colour of the very dilute solutions is a pale rose-red, and this deepens and becomes a bright rose-red when the absorption in the green is complete.

Solutions of Magenta.—Very dilute aqueous solutions of this dye-stuff exhibit a well-defined absorption band covering the spectral range from 540 mμ to 560 mμ in the green, while the colour of the transmitted light is a rose-red. Further additions of the dye-stuff result in this band extending up to 590 mμ, and also in a general absorption which weakens the transmission of the blue and green of the spectrum. The colour of the transmitted light then turns to a brilliant red.

Solutions of Methyl Blue.—This dye-stuff exhibits a powerful absorption in the wavelength range 650 mμ to 680 mμ which appears as a dark band crossing the spectrum of very dilute solutions. With successive additions of the dye-stuff, this absorption spreads out in both directions. The transmitted light exhibits a full blue colour when the cut-off of the shorter wavelength extends up to 570 mμ, despite the fact that the green sector then appears with undiminished intensity along with the blue and there is also an observable transmission at the extreme red end of the spectrum. Further additions of the dye-stuff which shift the position of the cut-off to 550 mμ reduce the observed

intensity of the transmitted light but have no noticeable effect on its colour.

Solutions of Methyl Green.—Despite its name, a fairly strong solution of this dye-stuff in a cell two centimetres thick appears of a full blue colour, the spectrum of the transmitted light covering the wavelength range from 450 mμ to 550 mμ, besides a narrow band in the red at 700 mμ; the intermediate region from 550 mμ to 700 mμ exhibits a practically complete absorption. Dilution results in the absorption band becoming narrower, then covering the wavelength range from 570 mμ to 680 mμ; and the transmission of the blue then extends to 440 mμ. In these circumstances, the green of the spectrum appears with full strength in the transmitted light; nevertheless, the perceived colour remains blue. Not until the dilution is carried much further and there is free transmission up to 590 mμ, does the colour change to a light greenish-blue.

Results of the Study.—We now proceed to state the conclusions which follow from the observations set forth above. The major result which emerges from the studies made with a variety of materials differing widely in their chromatic behaviour is the immense importance of the role played by the yellow sector of the spectrum and, in particular, by the wavelength range between 570 mμ and 590 mμ, in the perception of light and colour. The presence or absence of this range of wavelengths in the light received by the eye of the observer makes all the difference to the visual impressions produced by it.

First of all, we may refer to the most surprising result of all, *viz.,* that the removal of the yellow sector from white light, other things remaining the same, results in producing the colour sensation familiarly known as purple. Numerous examples of this finding have been set out above. Many further illustrations that emerge from the studies of floral colour and of the hues exhibited by various natural and synthetic products will form the subject of later chapters.

If in the composite light under observation, the blue sector is stronger relatively to the red sector than is normally the case while the yellow sector is absent, the colour sensation would be a bluish-purple. The weaker the red sector is, the more nearly would the bluish-purple resemble blue in its characters. If the situation is reversed and the red sector is stronger relatively to the blue than it is normally, the colour perceived is a reddish-purple, tending more and more to resemble red in the limiting case when the blue is very weak.

More generally, the studies indicate that the presence in full strength of the part of the spectrum lying within the wavelength range 560 mμ to 600 mμ is incompatible with the excitation by composite light of the highly chromatic sensations described by the terms blue, green or red. Only in the absence of the yellow sector of the spectrum can these colours be perceived at all, or at least without being modified to such an extent as to be unrecognisable.

The studies also furnish evidence of the existence of a physiological phenomenon which may be conveniently termed as the masking of one colour by another. An effect of this nature very clearly manifests itself when the composite light includes both the parts of the spectrum which we have referred to as the blue sector and the green sector. When the spectrum of white light is visually observed either through a prismatic spectroscope or through a diffraction grating, the green of the spectrum between 500 mμ and 560 mμ appears far more luminous than the part of the spectrum between 400 mμ and 500 mμ. Nevertheless, the light transmitted by a filter which passes both of these regions freely but cuts out the light of greater wavelengths appears of a blue colour without any indication appearing of its admixture with green light.

ABNORMAL HYSTERESIS LOOPS OF SOME MAGNETIC MINERALS AND ROCKS

C. RADHAKRISHNAMURTY AND P. W. SAHASRABUDHE

Tata Institute of Fundamental Research, Bombay

SEVERAL instruments have been developed for the direct display of hysteresis loops of synthetic alloy specimens in the form of wire and powder,[1] or thin films.[2] Bruckshaw and Rao[3] studied the hysteresis of rocks in moderate alternating fields, but without displaying the hysteresis loop directly.

We have recently developed a high field hysteresis loop tracer for magnetic minerals and rocks. In this, we have made use of a laminated core made of oriented grain silicon-steel (marketed by the English Electric Company of England) to function as an alternating current electromagnet. Using the commercial 50 cps. mains supply to energize the electromagnet a peak field of 3,600 oersteds could be obtained over a half-inch gap with only 90 volt-amperes. The core itself has almost negligible hysteresis loss and the field produced by it is quite sinusoidal with very little distortion. A suitable pick-up coil system placed within the pole-gap of the electromagnet has been used for detecting the magnetism induced in the samples. The apparatus can take up to about 4 c.c. specimen in the form of a cylinder of 2·2 cm. diameter and 1·1 cm. thickness. The details of the construction and the operation of the apparatus will be published elsewhere.[4]

In Fig. 1, *a*, *b*, *c* and *d* are shown respectively the hysteresis loops obtained for natural magnetite, hematite, pyrrhotite and a sample of basalt. The loops were obtained in a peak field of 2,400 oersteds which was found to be quite adequate to provide saturation for the minerals studied. The hysteresis loops for magnetite and hematite (Fig. 1, *a* and *b*) are normal whereas the other two show constrictions in the central portion. The observations of constricted loops in the case of Perminvar have been made earlier and similar behaviours have also been recently observed for some ferrites.[5,7] Other types of asymmetric loops have also been obtained for ferrites.[8] However, all these hysteresis loop types were obtained after suitable thermal treatment of the concerned substances.

In general, the natural minerals and rocks are apt to contain more than one magnetic constituent having different properties and these could be expected to affect the overall shape of the hysteresis loops of such mixed samples.

To understand this problem we have studied the hysteresis loops for mixtures of various minerals in known proportions.
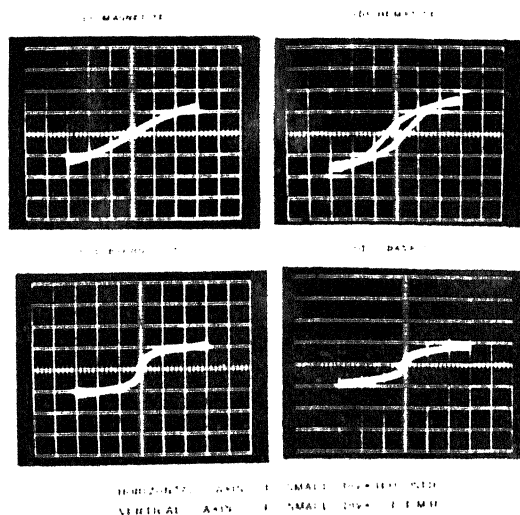
FIG. 1
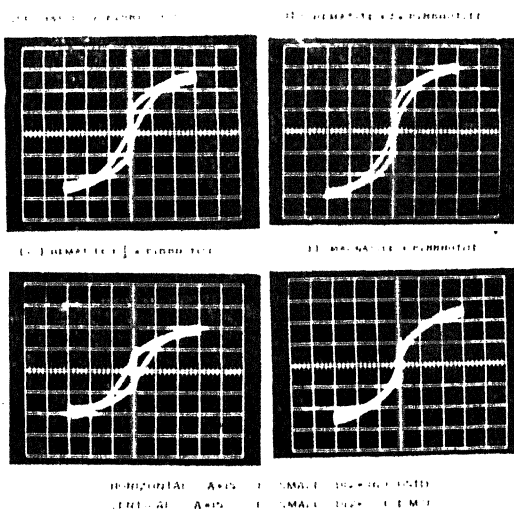
FIG. 2

In Fig. 2, *a* is shown a hysteresis loop for a mixture (two substances placed together as lumps) of hematite and pyrrhotite whose individual hysteresis loops are shown in Fig. 1, *b* and *c*. Keeping the amount of hematite the same, the proportion of pyrrhotite was altered

to twice and one-half of the amounts used in the earlier case and the corresponding hysteresis loops obtained for these mixtures are shown in Fig. 2, b and c respectively. In Fig. 2, d is shown the loop obtained for the mixture of magnetite and pyrrhotite whose individual loops are shown in Fig. 1, a and c.

For the present discussion the hysteresis loops of the type shown in Fig. 1, a and b are considered as normal whereas those shown in Fig. 2 (having constriction or changes in the slope of the trace) are treated as abnormal. It can be easily seen from the above figures that the loop for a mixture of two components is obtained by adding algebraically the individual loops of the two components taken separately, e.g., the addition of loops of Fig. 1, b and c gives the loop shown in Fig. 2, a. Since the specimens dealt with herein are magnetically weak it can be expected that the demagnetizing fields of the individual components and the effect on the field seen by any one component due to the presence of the other will be negligibly small. The results of algebraic additions can therefore be expected to be in close agreement and this has been confirmed by graphic analyses in a number of cases.

It is extremely interesting to note the following features of the abnormal loops. Firstly, the apparent coercive force of the mixture seen from the loop is nearer to that of the member having the higher intensity of remanent magnetization. Secondly, the overall remanent intensity and maximum intensity depend on the relative proportions of the two components and therefore also determine the overall shape of the loop. Thirdly, the hysteresis loss in the mixture remains the same, i.e., the area of the composite loop is equal to the sum of the areas of the two individual loops. Finally, the major features of the abnormal loops such as constrictions or otherwise, or abrupt changes in the slope of the loop-trace are mostly determined by the differences in the magnetic properties of the individual components present in the mixture.

Thus, the above constricted loops can be regarded as produced by the large difference in the relative rates of growth and decay of magnetization of the two components, particularly in low fields. In view of the above observations, even though one can attribute the abnormality of a given hysteresis loop to the presence in the sample of more than one constituent possessing different magnetic properties, one cannot deduce uniquely the individual components giving rise to a parti-

cular abnormal loop even when only two components are known to be present. One can therefore visualize the complexity in cases where more than two components are present in a sample. In Fig. 3 is given a hysteresis loop of a mixture of magnetite, hematite and pyrrhotite the individual loops for which are shown in Fig. 1, a, b and c. This loop of Fig. 3 looks similar
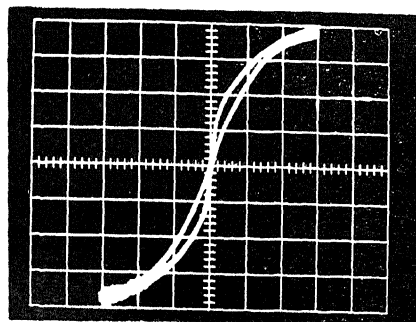
HEMATITE + PYRRHOTITE + MAGNETITE

HORIZONTAL AXIS   I SMALL DIV. = I60 OSTD
VERTICAL AXIS   I SMALL DIV. = I E. M. U.

FIG. 3.

to those of Fig. 2, a and b indicating that the addition of a third component does not materially affect the shape of the loop. Thus, given an abnormal loop it would not be easy to say whether the substance concerned has two components or more. This limiting situation is probably further enhanced by the inherent lack of resolving power of the apparatus to resolve the fine structures of the loops. This poor resolution can be understood in the following manner : Each small division of the horizontal and vertical axes in the scale shown in the above figures represents respectively 160 oersteds and 1 e.m.u. (the latter denoting the magnetic moment of the sample) and the trace thickness itself is about half a division. Therefore, finer structures of the loops involving variations of a few e.m.u. in the sample will not be easily perceptible on the loop-trace.

As quoted by Elmen,[5] the possibility that a substance may exhibit a variety of hysteresis loops if it consists of more than one magnetic component having different magnetic properties was first implicitly pointed out by Gumlich. However, the suggestion has probably not been considered very critically in subsequent studies.

Our studies clearly show that it is possible to explain the different types of abnormalities of hysteresis loops in terms of the mixed nature

of the sample, particularly in cases where the samples concerned are mixtures of minerals which would be characterized by weaker magnetic interactions of the inter-constituent type. On the other hand, when the individual constituents used in the mixtures are strongly magnetic such as the high coercive and high permeability substances, Alcomax, mu-metal or

(a) ALCOMAX   (b) NETIC

(c) ALCOMAX + NETIC

HORIZONTAL AXIS   1 SMALL DIV. = 160 OSTD
VERTICAL AXIS   1 SMALL DIV = 1 E.M.U

FIG. 4

other shielding materials, *e.g.,* Netic and Co-Netic, the algebraic summation of individual loops may not hold strictly on account of the large interactions between the individual substances. Nevertheless, a strong qualitative agreement in the case of such substances has

been observed experimentally and also graphically.

A typical set of loops for such commercial substances is shown in Fig. 4. The composite loop of Fig. 4, c shows a constriction whereas the loops for individual constituents (Alcomax and Netic, Fig. 4, a and b) are normal.

One may hope that a better understanding of the magnetic interactions between components having widely different magnetic properties in a mixture may render the explanation of even other types of abnormal loops possible.

Further studies of this type with a large variety of minerals and alloys are underway and will be reported in due course.

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HEAVY MINERAL INVESTIGATIONS IN NAHAN SERIES NEAR NAHAN, HIMACHAL PRADESH*

R. N. SINHA AND K. N. KHAN

Petrology Laboratory, Oil & Natural Gas Commission, 37-A, Curzon Road, Dehra Dun

INTRODUCTION

THE heavy mineral suite of Nahan Series exposed approximately six miles east of Nahan (30° 34' : 77° 18' ; Survey of India Topo Sheet No. 53 F/6, Himachal Pradesh) along Bata Nala (30° 21' 50" : 77° 24' 20" to 30° 34' 30" : 77° 24' 10") has been studied. Such studies

have been found useful for attempting local correlation of Siwalik rocks.[2,6] The Nahan Series are devoid of sufficient polospore or faunal assemblages for correlation and age determination. They, however, are correlated with Lower Siwaliks on the basis of lithologic characters.[1]

The Nahan Series of the type area around Nahan is correlated with Lower Siwaliks mainly on basis of lithologic characters.[3,5,7] According to Pascoe[5] the Nahan Series exposed in the neighbourhood of Haritalyangar (31° 32' : 76° 43') has yielded *Conohyus chinjiensis* Pilg.,

which is characteristic of Chinji (Upper Tortonian).

The Nahan Series forms a 4,475 ft. thick sequence (Fig. 1) and is part of the autoch-

HEAVY MINERAL RANGES IN NAHAN SERIES, NAHAN (H. P.)
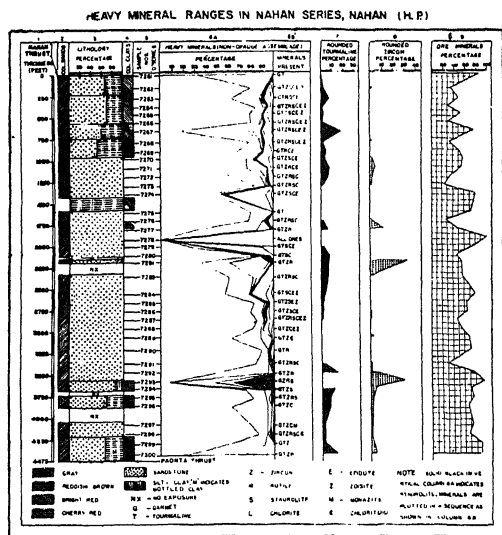
FIG. 1

thonous belt of Himalayan foothills. They are separated from the Upper Siwaliks (Astian to Cromerian) by Paonta Thrust towards the south and from the older as well as pre-Tertiary rocks (Subathu-Auversian to Bartonian and Dagshai-Aquitanian†) by Nahan Thrust towards the north. They are mostly grey coloured, hard, medium grained, micaceous argillaceous and occasionally calcareous sandstones. Sometimes the sandstones contain intra-formational clay-conglomerates and are harder, indurated as well as fractured nearer the thrusts. The associated clays are silty and rarely mottled and of reddish-brown, bright red and cherry-red colours (Fig. 1). Streaks of lignite are traceable.[1]

Heavy Mineral Study

A total of 39 samples (mainly sandstones), collected at 100 feet stratigraphic interval, were treated to isolate heavy minerals. Disintegration of samples was achieved by soaking in water and treatment with boiling N/10 HCl. After washing (to remove clays) and subsequent drying, the sand fraction was sieved

to get a fraction of 88 to 250 microns grade.‡ The heavy minerals were separated from this fraction by using bromoform (sp. gr. 2·9). They were first studied in liquid mounts for qualitative estimations and later counted for quantitative estimations. The percentage of various components is presented in Fig. 1. A total of ten heavy minerals is recognized. Only seven of these are persistent. The more common include abundant to fairly abundant garnet; common to very common tourmaline; scarce to common epidote, staurolite, chlorite and zircon and rare to scarce rutile. The rest include zoisite, chloritoid and monazite. Ore minerals are fairly abundant. The general characters of more common heavy minerals are as given below :

Ore Minerals.—Include angular to sub-rounded opaque minerals. Magnetite is dominant. Hematite and pyrite are comparatively rare.

Garnet.—Usually pinkish and/or colourless, less frequently brownish, angular to subrounded, fractured, pitted and contain inclusions of quartz and ore minerals. Some show strain shadows and are pseudoisotropic.

Tourmaline.—Usually brown to light brown and yellow, strained, subangular to subrounded, fractured and contain inclusions of quartz. A few, though rare, show good rounding.

Epidote.—Generally colourless or light greenish, angular to subrounded and fractured.

Staurolite.—The most common are straw-yellow to reddish-brown, angular to subrounded and with hackly fractures and inclusions.

Chlorite.—Green to pale green and contain inclusions of ore minerals (usually magnetite ?).

Zircon.—Colourless to brown, subrounded and fractured.

Rutile.—Usually red, less frequently yellow, subangular to subrounded and fractured.

Comparison with Lower Siwaliks

Recent investigations of heavy mineral suites have shown that the Lower Siwaliks of Jwalamukhi and neighbouring areas in Punjab are characterized by presence of yellow tourmaline and staurolite.[2] Kyanite characterises Middle Siwaliks of Punjab[6] and thus helps in differentiating them from Lower Siwaliks. Pre-Siwaliks of Punjab and Himachal Pradesh are recognised by presence of barite and absence of both kyanite and staurolite.[6] A comparison of the heavy mineral suites of Lower Siwaliks and Nahan Series exposed along Bata Nala indicates that they are quite similar to one another.

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† After Krishnan, 1960, table 66, p. 499.

‡ Prolonged experimentation has shown that this fraction yields a fairly large and representative heavy mineral residue.

Both are characterized by presence of staurolite and absence of kyanite. Heavy mineral residues, hence, offer an additional criterion for correlating Nahan Series with Lower Siwaliks.

PROVENANCE

The light crop (fraction with sp. gr. less than 2·9) contains igneous and metamorphic quartz along with some feldspars. The heavy mineral suites also consist of index metamorphic minerals (*e.g.*, epidote, garnet and staurolite) besides others (*e.g.*, tourmaline, zircon and rutile) which could only be derived from igneous rocks. Reworking of minerals is absent. The sandstones are texturally immature and poorly sorted. They contain a good percentage of unstable detrital components (*e.g.*, shaly and schistose rock fragments, chlorite and micas) as well as argillaceous matter. Most of the detrital components are subangular to subrounded and thus do not indicate long-distance transportation. It appears that the sediments were derived from igneous and metamorphic rocks exposed in the nearby area (possibly Himalayan region) and deposited probably in a shallow unstable basin.

CONCLUSION

The Nahan Series of Bata Nala Section, which has been already correlated with Lower Siwaliks on basis of lithologic characters, is unfossiliferous. The present study indicates that its heavy mineral suite is comparable to that of Lower Siwaliks providing additional criteria for correlating the two. The provenance appears to have been near the place of deposition and it consisted of igneous and metamorphic rocks.

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THE INTERIOR OF MARS

THERE are marked differences between the internal structure of the four inner or terrestrial planets—Mars, Earth, Venus and Mercury—and the major planets Jupiter, Saturn, Uranus and Neptune. The terrestrial planets are solid bodies whereas the major planets are largely, if not entirely, gaseous. Of the terrestrial planets only the structure of the Earth can be directly investigated. However, by assuming that these planets are all composed of similar materials it is feasible to build a picture of their possible structure.

Such a study using simple hydrostatic theory and certain geophysical characteristics of the earth has recently been made by Professor R. A. Lyttleton for Mars and Mercury. Structurally, the Earth may be divided into three principal zones—a liquid core surrounded by two zones of solid material. Mars has no liquid core and a model for Mars need only have two zones. Lyttleton's study leads to the following broad results regarding the interior of Mars: It should have a solid core containing 53 to 82% of the planet's mass. The predicted radius lies between 3355 and 3418 kilometres, thus confirming the presently known value of 3380 kilometres. If Mars had heated up slightly since its formation, some expansion of the planet would have resulted. Some rifting of the planet's surface—but no mountain forming—would be expected. —(*Science Journal*, April 1965.)

LETTERS TO THE EDITOR

DIELECTRIC PROPERTIES OF SOME LIQUIDS AT 8 mm WAVELENGTH

IN an earlier communication from this laboratory, Muralidhara Rao[1] described a method of determining the dielectric constant, ϵ', and dielectric loss, ϵ'', in the mm wave region using an interferometric method similar to the one described by Vaughan, Bergmann and Smyth.[2] The importance of this method need not be stressed since the uncertainties in the conventional standing wave method increase as the wavelength decreases, in view of the small dimensions of the components. The mounting of the receiver and transmission horns has been improved so as to facilitate slow and accurate relative orientation and adjustment. This has enabled measurements to be taken for different positions of the detector horn minimising the interaction between the transmitting and receiving horns.

Using this improved arrangement ϵ' and ϵ'' of six liquids have been determined at 8·3 mm wavelength. For the first five of these, new data have enabled the determination of more reliable values of the distribution parameter a and the relaxation time τ, particularly for n-butyl acetate, than was possible from the low frequency data alone.[3] Table I gives these

$(\tau = 4·6 \times 10^{-12}$ sec.) that of ethyl acetate.[4] This may be due to the high molecular weight of the chloro acetate and its higher dipole moment of 2·64 D[5] compared to that of ethyl acetate $(\mu = 1·80$ D[5]$)$.
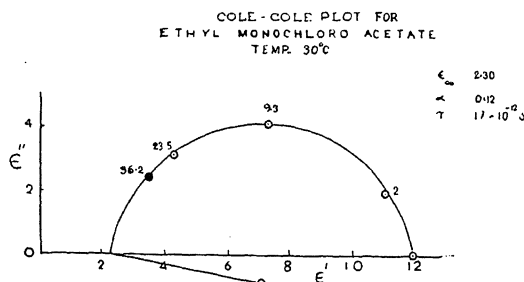
FIG. 1. Cole-Cole plot for ethyl monochloro acetate (Numbers besides points indicate frequencies in kmc./sec.).

The authors are indebted to Prof. K. R. Rao for his guidance. One of the authors (C. H.) is grateful to the Council of Scientific and Industrial Research for the award of a Fellowship.

Department of Physics,   C. HARANADH.
Andhra University,   C. R. K. MURTY.
Waltair, March 18, 1965.

TABLE I
Dielectric dispersion data at 30° C.

Substance	Experimental		Calculated		α	τ Sec.
	ϵ'	ϵ''	ϵ'	ϵ''		
1. n-Bromo hexane	2·70	0·90	2·80	0·93	0·165	$16·5 \times 10^{-12}$
2. Benzyl acetate	2·90	0·70	2·76	0·78	0·177	$13·4 \times 10^{-12}$
3. Butyl acetate	3·21	1·00	3·40	1·08	0·110	$5·3 \times 10^{-12}$
4. Methyl salicylate	2·64	0·58	2·63	0·53	0	$3·35 \times 10^{-12}$
5. Iso-amylchloride	2·87	1·52	2·83	1·48	0	$9·6 \times 10^{-12}$
6. Ethyl monochloro-acetate	3·53	2·44	3·46	2·42	0·120	$17·0 \times 10^{-12}$

data together with observed and calculated values of ϵ' and ϵ'' at 8·3 mm.

Ethyl monochloro acetate has not been previously investigated and hence the dispersion is studied in the present work also in the region 1 to 36·2 kmc./s. The results are plotted in Fig. 1 and the derived parameters a and τ are given in Table I. It is observed that the relaxation time is considerably greater than

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CLOSED LOOP PATTERNS ON CADMIUM SINGLE CRYSTALS

IN continuation of the work on the study of cadmium single crystal surfaces reported earlier from this laboratory[1] the author has observed closed loop patterns on the cadmium crystals. Similar closed loops have been reported recently from this laboratory on zinc single crystals.[2] That such closed loop patterns are formed from a pair of unlike dislocations is now an established fact[3] and this mechanism is similar to the Frank-Read source. Several workers have reported such patterns on different crystals.
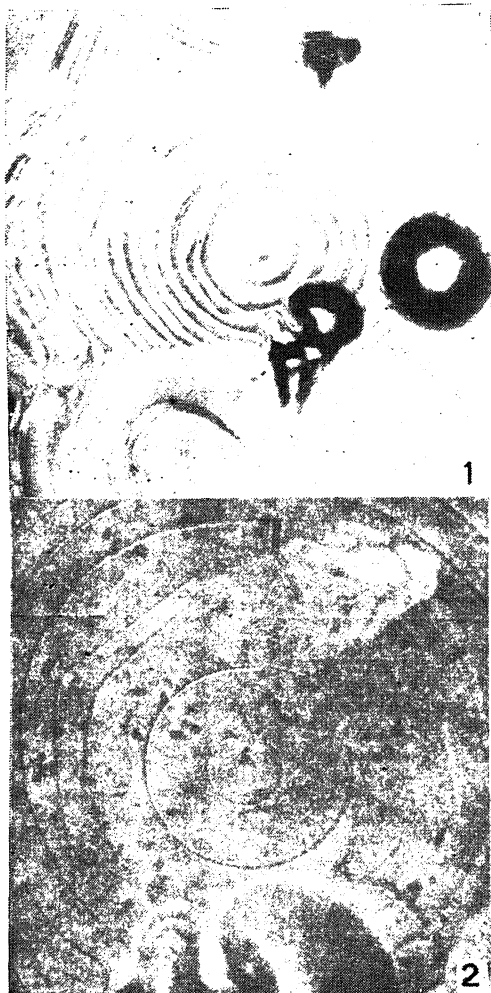
FIGS. 1-2. Fig. 1, × 255. Fig. 2, × 850.

Figure 1 shows phase-contrast micrograph of one such crystal surface of cadmium crystal grown in the laboratory by Bridgman's technique. Step height is not very large as even with oil immersion objective no shift in the profile micrograph was noticed. Figure 2 shows the enlarged central portion of the closed loop of Fig. 1. This clearly indicates the resultant loop formation due to two opposite types of screw dislocations near each other. These facets were formed on the free surface of the main crystal obtained from melt. The patterns are due to the growth from vapour phase as reported earlier.[2]

The author is grateful to Prof. N. S. Pandya for his keen interest and guidance and is thankful to the Council of Scientific and Industrial Research, New Delhi, for the award of Junior Research Fellowship.

Physics Department,   A. S. THATTEY.
M.S. University,
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CHEMICAL INVESTIGATION OF LAC HOSTS

I. *Zizyphus jujuba* and *Z. xylophora*

THE lac insect is known to thrive well only on certain host trees. What actually is the deciding factor is unknown. The hosts are quite large in number and also belong to diverse families. An investigation of the chemical components of the lac hosts has now been undertaken in order to explore the possible connection between them and the ultimate secretion products of the insect. The genus *Zizyphus* was chosen first since it provides a large number of major lac hosts. The present investigation deals with the components of the bark and wood of *Z. jujuba* known under the common name "ber" and *Z. xylophora* known as "ghont".

There have been some reports in the literature on the components of *Zizyphus* species which have been reported to have medicinal properties. A Chinese tonic *Hsuan Tsao Re*[1] is an extract of the seeds of *Z. vulgaris* which contains betulinic acid.[2] Recently betulinic acid and some peptides have been reported from the root bark of *Z. oenoplia*.[3]

Bark of Z. jujuba.—The bark obtained from the Lac Research Institute, Ranchi, was successively extracted with light petroleum (60–80°), ether and alcohol. The ether extract gave betulinic acid (1) in a yield of 1% isolated as the sparingly soluble sodium salt. Its identity was

established by the preparation of the methyl ester, dihydro methyl ester and methyl ester acetate, comparison with a sample of authentic methyl betulinate and comparison of their infra-red spectra. The alcohol extract gave leucocyanidin identified by boiling with alcoholic hydrochloric acid to give cyanidin chloride followed by paper chromatography of the flavylium salt with the system n-butanol : acetic acid : water (4 : 1 : 5 ; upper phase), as well as by the visible spectrum of the anthocyanidin chloride.

Wood of Z. jujuba.—The wood was likewise extracted with acetone. The acetone extract on concentration gave a brown solid (A) to the extent of $1 \cdot 0$–$1 \cdot 2\%$. The clear filtrate was diluted with water and filtered again. The aqueous solution was repeatedly extracted with ethyl acetate and the extract dried over magnesium sulphate. Addition of light petroleum gave a colourless powder. The infra-red spectrum of this product was free from carbonyl absorption. It was identified as a leucopelargonidin $[\alpha]_D^{20°} = +24$ (C = 0.91 ; ethanol) by boiling with alcoholic hydrochloric acid to give pelargonidin chloride followed by paper chromatography and study of visible spectrum as mentioned earlier. It formed a trimethyl ether with diazomethane, m.p. 228° (decomp.) ; $[\alpha]_D^{21 \cdot 5} = +71 \cdot 4$ (C = 0.58 ; ethanol). Potassium permanganate oxidation of the trimethyl ether gave anisic acid, identified by paper chromatography.

The brown solid (A) was extracted in a soxhlet successively with light petroleum and ether. The ether extract was fractionated into bicarbonate, carbonate and hydroxide soluble parts. From the carbonate extraction minor amounts of betulinic acid were obtained as the sparingly soluble sodium salt. From the remaining carbonate solution a solid (0·8–1% of the wood) was obtained on acidification, m.p. 350° ; its infra-red and n.m.r. spectra showed that it also belonged to the lupeol group. It gave a dimethyl ester, a dihydro derivative and a dimethyl ester acetate. All their properties showed that the acid was ceanothic acid (II) whose constitution was established by Starret and de Mayo in 1961.[4] It belongs to a rare type with a five-membered ring A. This acid has so far been isolated only from the family *Rhamnacea*[5] to which *Zizyphus* also belongs. In many sources it occurs along with betulinic acid and the possible biogenetic significance has been discussed by Starret and de Mayo. The identity of the present sample was confirmed by direct comparison with the one presumably isolated from *Alphitonia* species and kindly supplied by Dr. Simes of the University of New South Wales, Australia.

I   II
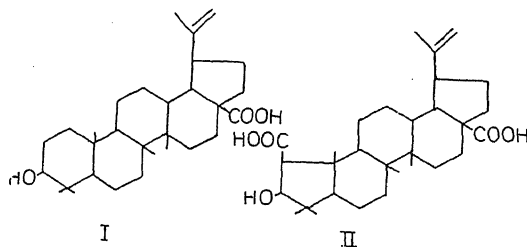
Bark and Wood of Z. xylophora.—A similar examination of this bark revealed the occurrence of betulinic acid (1%). However, the wood of this species does not show any appreciable amounts of either triterpenes or leuco-anthocyanidins.

It is interesting to note that the family *Rhamnaceœ* produces the triterpenes belonging to the lupeol series in large quantities. The genus *Zizyphus* itself appears to be an abundant source for betulinic acid and also for ceanothic acid. However no possible interrelationship could be envisaged between these components and the lac resin itself.

We thank the Director, Indian Lac Research Institute, for a generous supply of lac hosts.

Dept. of Chemistry,   Harbhajan Singh.
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AMINO-ACID COMPOSITION OF *CLADONIA RANGIFERINA, CLADONIA GRACILIS* AND *LOBARIA ISIDIOSA*

In continuation of our earlier work[1,2] on the amino-acid composition of Indian lichens, we have studied *Cladonia rangiferina, Cladonia gracilis* and *Lobaria isidiosa* collected from the Himalayan ranges, for their amino-acids and our results are reported in brief.

Cladonia rangiferina (Linn.) Web., commonly described as 'reindeer moss', is a good fodder lichen reported to contain about 60% carbo-

hydrate (lichenin).[3] The milk of reindeer (feeding on this lichen) is reported to be highly nutritive, particularly rich in fat[4] (about 22·5%). There appears to be no earlier report on the amino-acid composition of this lichen. A sample of the lichen from the Valley of Flowers (alt. 11,500 ft.) has been found to contain about 6% crude protein (Kjeldahl estimation) and 35% of carbohydrate (in terms of glucose obtained after acid hydrolysis). Similarly, *Cladonia gracilis* (L.) Willd. var. *Chordalis* (Flk.), *Shœr f. foliosa* from Ganghariya area (alt. 10,000 ft.) has been found to contain 6·2% of crude protein and 30% of carbohydrate. A sample of *Lobaria isidiosa* (Mull. Arg.) Vain. from Joshimath area (alt. 7,500 ft.) investigated now has been found to contain as much as 22% of crude protein (comparing with *Peltigera canina* earlier reported[2]) and about 15% of carbohydrate.

In view of the fodder value of *C. rangiferina* and the high protein content of *L. isidiosa,* the amino-acids of these lichens have been studied in detail adopting the earlier procedure of extraction[2] and ascending two-dimensional paper chromatography using Whatman No. 3 filter-paper and solvent systems, *n*-butanol: acetic acid : water (4:1:1) in one direction and pyridine : isoamyl alcohol : water (10:10:7) for the other. A semi-quantitative assessment of the concentration of the amino-acids was also made by visual comparison of colour intensities (ninhydrin) developed with known concentration of amino-acids and the results are given in Table I.

Special mention may be made of the advantage of the systems of solvents now employed giving a clearer separation of amino-acids as in the case of acid hydrolysate of *C. rangiferina* (Fig. 1) over the other systems reported
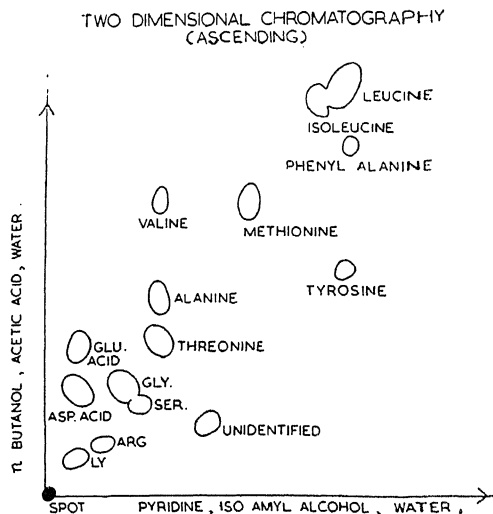
FIG. 1. Paper chromatogram of the amino-acids of acid hydrolysate of *Cladonia rangiferina.* (1) *n*-Butanol : Acetic Acid : Water = 4 : 1 : 1. (2) Pyridine : Isoamyl alcohol : Water = 10 : 10 : 7.

earlier.[5,6] In descending two-dimensional paper chromatography with the present solvent systems, there is a good separation of leucine and isoleucine also. For the tropical conditions in our laboratories with much sunlight, pyridine can be preferred to phenol, as distilled pyridine

TABLE I

Amino-acid composition of Cladonia rangiferina, Cladonia gracilis *and* Lobaria isidiosa

Sl. No.	Amino-acids		*C. rangiferina*		*C. gracilis*		*L. isidiosa*	
			Free*	Combined †	Free*	Combined †	Free*	Combined †
1	Alanine	..	+	2+	3+	+	+	3+
2	Arginine	..	+	+	+	+	..	2+
3	Aspartic acid	..	..	2+	..	2+	..	2+
4	Glutamic acid	..	..	2+	+	2+	+	2+
5	Glycine	..	..	2+	+	2+	..	2+
6	Histidine	..	..	..	..	..	..	+
7	Isoleucine	..	..	+	..	+	..	+
8	Leucine	..	+	2+	2+	2+	+	2+
9	Lysine	..	..	+	..	+	..	2+
10	Methionine	..	..	+	..	+	..	2+
11	Phenyl alanine	..	..	+	..	+	..	2+
12	Proline	..	..	..	..	..	..	+
13	Serine	..	+	2+	+	2+	+	2+
14	Threonine	..	..	2+	+	+	+	2+
15	Tryptophan	..	..	trace	trace	trace	trace	+
16	Tyrosine	..	+	+	2+	+	+	+
17	Valine	..	+	+	+	+	+	+
18	Unidentified	..	..	2+	..	2+	..	2+

* Each '+' indicates about 3 mg. % of the dry lichen.   † Each '+' indicates about 200 mg. % of the dry lichen.

keeps better for longer periods than phenol and the drying of the paper after running the chromatogram is quicker in the case of pyridine than in the case of phenol.

In view of the clearer separation of amino-acids by means of two-dimensional paper chromatography using the solvent systems mentioned above, the amino-acid composition of *Roccella montagnei*, *Parmelia tinctorum* and *Peltigera canina* reported earlier[1,2] has been re-examined and in addition to the amino-acids reported, glutamic acid, aspartic acid, methionine and a trace of tryptophan could be identified in the hydrolysates of *R. montagnei* and *P. tinctorum* while *P. canina* was found to contain glutamic acid, aspartic acid and histidine also in its hydrolysate. Further, in all the lichens a common characteristic ninhydrin-positive spot (Fig. 1) with R_f 0·11 in the butanol system and 0·23 in the pyridine system which could not be identified with any of the common amino-acids has been noticed.

We thank Prof. T. R. Seshadri for his kind interest in this work and the samples of lichens, and Principal, Dr. D. J. Reddy, for encouragement.

Dept. of Chemistry,   S. RAMAKRISHNAN.
Jawaharlal Institute   S. SANKARA SUBRAMANIAN.
   of Post-Graduate Medical Education
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PEROXIDASE ACTIVITY AND IRON DEFICIENCY IN SOYBEAN LEAF TISSUE

WHEN plants are starving for any of the essential nutrients, characteristic symptoms usually appear as certain abnormalities, discoloration and deformation of leaves, fruits and other parts. The deficiency symptoms though quite apparent in advanced stages of plant growth, are not easily recognizable in several cases at the beginning. The characteristic symptoms of iron deficiency in plant nutrition is chlorosis. In an experiment, soybean plants

did not exhibit visible symptoms of chlorosis when grown in nutrient medium devoid of iron. Iron itself does not enter into the composition of chlorophyll molecule. However, iron in leaves is found to occur in combination with some proteinous fractions, presumably enzymes, which activate formation of certain other proteins intimately related to chlorophyll.

The importance of enzymes in the physiology of plants is being appreciated more and more as a wide spectrum of enzymes have been purified, characterised and their biochemistry studied in detail. Arnon (1951) considered the approach of estimating the activity of enzyme systems controlled by iron to evaluate chlorosis as the pertinent one to follow. Brown and Hendricks (1952) postulated that when a nutrient is limiting in the nutrition of plant, the deficiency will be indicated by a reduced activity of an enzyme requiring this element.

Peroxidase is a conjugated protein containing iron porphyrin as its prosthetic group. Iron deficiency would therefore impress upon the peroxidase activity in leaves apparently not exhibiting chlorosis. An experiment was therefore conducted to examine if the measurement of peroxidase activity would indicate latent iron deficiency.

Two sets of soybean plants were raised in solution culture under identical conditions of nutrient level, light and temperature (in a plant growth chamber). However one set of plants received only 0·25 p.p.m. iron supply in the culture medium. There were no symptoms of chlorosis on leaves of both the sets of plants. When the plants were three weeks old, six replicated leaf samples were collected separately from both the sets of plants for estimating peroxidase activity. The preparation of enzyme and the measurement of its activity in the leaf samples were done by adopting the convenient methods described by Perur elsewhere (1962). The results are given in Table I.

As stated above the set of plants that received very low supply of iron apparently did not exhibit symptoms of iron deficiency (chlorosis) on their leaves. However, the low iron supply had influence on the peroxidase activity of the leaf tissue. There was a substantial reduction in the enzyme activity as a result of iron deficiency. The reduction was to the extent of about 71%. The results of the investigation therefore lead to the conclusion that the measurement of peroxidase activity served as an indicator of the hidden deficiency of iron in soybean plants.

TABLE I

Peroxidase activity in soybean leaves from
plants grown in nutrient solution with or
without adequate iron

Replications	Normal	Low iron	Normal but boiled	Blank
	(In units of the instrument dial)			
1	6·1	0·9	0·0	0·0
2	8·4	1·2	..	..
3	4·0	1·3	..	..
4	6·1	2·6	..	..
5	5·3	1·9	..	..
6	5·8	1·6	..	..
Mean	5·6	1·6	..	..

Agronomy Department,   N. G. PERUR.
Utah State University,   R. L. SMITH.
Logan (Utah), U.S.A.,   HERMAN H. WIEBE.
January 8, 1965.

* Change in optical densitiy of pyrogallol solution by
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A NOTE ON THE TRIAL OF TWO MODERN RATTICIDES

WORK has been going on at this Institute for
sometime to evaluate new ratticides as baits to
be used for rat control. The major population
of rats in Bombay consists of *R. rattus, B. benga-
lensis* and *R. norvegicus*[1] ; the trials were there-
fore done on these three rats only.

R. rattus, R. norvegicus and *B. bengalensis*
were collected from different wards, defleased
and held in the laboratory for a minimum period
of one month on the laboratory diet. Those rats
that survived this period and were healthy were
observed for the frequency of their pellets and
selected for trial. The rats were given the
necessary baits with the food and water and
observed on a comparative basis with the con-
trols. Where possible the food was coloured
by carmine to enable the detection in pellets
and in the food in the gut after death.

The rat poisons tried were the commercial
products, Warfarin (trade name Dethmor[2]).
Prolin with an antibiotic content (brought out
recently by Prentes and Co.), Racumin, and
Shoxin or "Rati-cate", a specific rat poison
recently isolated by Roszkowksi et al.[3] The
first three are anti-coagulants and do not cause
bait shyness. A locally made warfarin in salt
solution was also tried. Recently Lund[4] has
reported resistance to warfarin in the common
rat.

Table I shows the performance of these
ratticides on *R. rattus, R. norvegicus* and
B. bengalensis. From this table it is apparent
that the four forms of anti-coagulants take a
minimum of 48 hours to kill. In the case of
Shoxin all *R. norvegicus* die within the time
claimed, *i.e.,* 30 minutes to 2 hours. In the
case of *R. rattus* only 60% die while *B. benga-
lensis* has not died at all. The concentration
was increased even to 0·36 gm./gm. in the bait
and only one *B. bengalensis* died in 36 hours.

It was further noticed that as compared to
the anti-coagulants the preference and uptake
of bait with Shoxin seemed to be only 50% in
R. rattus.

In recommending a ratticide for field trials
one has to take into account, apart from

TABLE I

Table showing the Results of Ratticide trials

Sl. No.	Ratticide tried	% of bait	R. rattus				R. norvegicus				B. bengalensis			
			Average food consumed in gm.	A	B	C	Average food consumed in gm.	A	B	C	Average food consumed in gm.	A	B	C
1	Control ..		99				104				110			
2	Warfarin ..	0·05	28·2	5·2 d.	10 d.	2 d.	28·8	4·4 d.	9 d.	2 d.	10·4	7·4 d.	12 d.	2 d.
3	Warfarin liquid	1 : 4000	24 ml.	5·4 .,	8 ,,	3 ,,	24 ml.	3·2 ,,	6 ,,	1 ,,	26 ml.	6·2 ,,	8 ,,	2 ,,
4	Prolin ..	0·05	38·9	5·1 ,,	12 ,,	2 ,	31·9	4·2 ,,	9 ,,	3 ,,	36·8	5·6 ,,	9 ,,	3 ,,
5	Racumin ..	0·04	39·2	4·2 ,,	7 ,,	3 ,,	35·3	5·2 ,,	9 ,,	2 ,,	50·7	5·2 ,,	9 ,,	1 ,,
6	Shoxin (McN 1025)	0·05	2·0	2 hrs.	4 hrs.	1 hr.	1·5	1·5 hr.	2 hr.	½ hr.	18·0	(No Mortality)		

A—mean period, B—Max. period, C—Min. period (mortality), D—days.

Remarks : 1. Mortality with Shoxin amongst *R. rattus* was only 60% ; 2. The average of 10 days has been
taken in control.

performance, the cost of the bait material consumed, the poison bait, and the laying expenses.

The author has estimated that the cost of killing one rat by an anti-coagulant would be about 25–40 paise and by Shoxin about 75–100 paise. The fact that anti-coagulants when used normally do not cause bait shyness has to be borne in mind. Secondly, the discovery of Shoxin is based on the fact that its toxicity is acute and limited to only a few members of Muridæ. This is a point in its favour and it needs to be exploited in a different way.

Zinc phosphide which we also tested in the laboratory and extensively used in the field at 1% concentration kills all the three rats between 3 and 12 hours and the cost would probably be cheaper.

I am thankful to my colleagues Messrs. Renapurkar, Vad, Chaturvedi and Shah for conducting the trials, the World Health Organisation for the supply of Shoxin, Messrs. Prentes and Co. for Prolin, Messrs. Bayer India Pvt. Ltd., for Racumin and Dr. R. C. Shah for the locally made Warfarin.

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EFFECT OF LEACHING SALINE-ALKALINE SOILS WITH DIFFERENT QUALITY OF WATERS

Reclamation of saline-alkaline soils essentially involves a process of leaching out the excess of salts and accomplishing an exchange of Ca^{++} for Na^+ adsorbed by the soil exchange complex. Low salt-water is recognized as an efficient agent for leaching out excess of soluble salts, and for reclaiming alkaline soils with the aid of various amendments.[1,2] However, very little is known about the effect of washing normal and saline-alkaline soils repeatedly with high salt-waters which are very frequently found in arid and semi-arid regions. With this aim in view, this investigation was taken up, and the results obtained are briefly discussed here.

Four types of sandy loam soils,—namely, normal, saline, saline-alkaline and alkaline,—and four same quality of waters were selected for this study. Electrical conductivity (Ec) of the saturation extract of soil as 4.00 mm. hos./cm. and exchangeable sodium percentage (ESP)

above 15 were taken as criteria for choosing saline and alkaline soils respectively. For saline waters Ec above 0.75, and for alkaline waters pH above 8.00 were taken as criteria. In one set of experiments, 50 g. soil sample was treated thrice with 200 ml. of different quality waters by filtering after every 12 hr. In another set, the same procedure was followed except that gypsum at two levels—5 M. tons (G 1) and 10 M. tons (G2) per 0.40 hectare of 30 cm. soil was added to soil prior to the water treatment. After washing, the samples were oven-dried and analysed for Ec, pH in 1 : 2 soil-water extract and exchangeable bases by the usual methods.[3]

The results obtained indicate that leaching of salts take place more efficiently from all types of soils with good and alkaline waters. When saline-alkaline water is used, the leaching is less effective probably because of retention of salts from the water used for leaching. With saline water the retention of salts is even greater with the result that the order of effectiveness in leaching salts from soil is, good or alkaline > saline-alkaline > saline water.

Experiments show that leaching of soils with normal or/and saline water causes no significant change in pH of the soils. There is an increase in pH of normal and saline soils when these are leached with saline-alkaline or/and alkaline waters. However, leaching of saline-alkaline and alkaline soil produces no change in pH values. ESP of soils, in general, increases as a result of leaching. The gypsum treatment, particularly at higher doses, has helped to reduce ESP values which in absence of gypsum has increased more in all type of soils under study. The result clearly indicates the usefulness of gypsum in reclamation of salt-affected soils with different quality waters.

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LOSS OF PHOSPHORUS FROM THE LEAVES OF RICE PLANT BY LEACHING THROUGH WATER

THERE are contradictory views on the leaching of minerals by rainfall from the leaves of the rice plants. It is an important factor to be reckoned as far as paddy is concerned, especially under conditions existing in Kerala where the paddy plants are subjected to leaching by heavy rainfall. In "japonica" variety, work had been carried out by A. Tanaka and S. A. Navasero (1963).

Of the three elements, nitrogen, phosphorus and potash, phosphorus is likely to be most resistant in this regard. Hence it can be fairly concluded that if phosphorus is removed, the other nutrients may be lost in greater proportions.

The present study is undertaken to investigate the loss of phosphorus from the fresh, mature, old and dried leaves of paddy through leaching by water.

Paddy leaves were collected as fresh young green, mature, green, older dried; older dried leaves cut and sun-dried from a manurial trial on rice and the phosphate loss on leaching with water was qualitatively estimated. The collected leaves were kept immersed in water overnight without dipping the cut end and tested for phosphate losses through water. The results as evaluated are given in Table I.

TABLE I

Loss of P_2O_5 by leaching from paddy leaves

Nature of leaves	P_2O_5 loss
Young	.. No loss
Mature green	.. Trace
Old dried	... Considerable quantities

by ammonium molybdate method (as per C. S. Piper, 1950). The P_2O_5 that remained in the residue and the total P_2O_5 of the samples were also analysed. The results are presented in Tables I and II. These results show that 49·46 to 57·88% of the total P_2O_5 is removable by leaching with water.

Japanese workers had reported that in "japonica" variety the loss of P_2O_5 is negligible while N_2 and K_2O are lost in considerable quantities. In the present study it had been shown that in the younger fresh leaves there is no loss of P_2O_5, while in the mature green leaves loss of small quantity of P_2O_5 was noted. In the older dried leaves the loss of P_2O_5 is considerable. It is evident that there is some mechanism by which P_2O_5 is held in the younger leaves. Even in these, if the leaves are dried, there is loss of P_2O_5 on leaching with water. Under water-logged condition the older leaves are likely to be dipping in standing water.

As can be seen from Table II, on an average more than 50% of the total P_2O_5 in the older leaves is water-soluble. It is a matter for study whether a temporary drought can create the same conditions as that was found when the leaves were dried artificially. One important feature which came out of the study was that the straw, during storage in the open, lost a major portion of its nutrients.

Agricultural College and   P. SUNDARESAN NAIR.
Research Institute,   N. SUBRAMONY.
Vellayani, Trivandrum,
September 14, 1964.

TABLE II

Water-soluble P_2O_5 in old dry leaves of paddy

Samples		Manurial details from which samples were collected			Water-soluble P_2O_5	Residual P_2O_5	Total P_2O_5	% of water-soluble P_2O_5
		N_2 lb./ acre as urea	P_2O_5 lb./ acre as super-phosphate	K_2O lb./ acre as muriate of potash				
I	..	20	20	10	0·204	0·153	0·358	57·88
II	..	20	20	20	0·209	0·191	0·400	53·44
III	..	40	20	10	0·201	0·175	0·376	52·96
IV	..	40	20	20	0·198	0·193	0·399	49·46

Samples of older leaves collected from a manurial trial on rice variety PTB. 9 were dried and representative samples were taken for analysis. Two grams of the sample was digested with 100 ml. of water for half an hour and filtered. In the filtrate, the P_2O_5 was estimated

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GLAUCONITIC MUDSTONE FROM 'RAGHAVAPURAM SHALE', WEST GODAVARI DISTRICT, ANDHRA PRADESH

THIS is to report the occurrence of glauconite in the Coastal gondwana sediments of Andhra Pradesh.

Near Raghavapuram (81° 19′ 42″ E. : 17° 02′ N.; G.T.S. 65 G/8) and adjacent hills, there are slightly indurated, olive, yellowish, grey-green to pale brownish-green, thin bands of mudstones within the 'Raghavapuram Shale' which contain the mineral glauconite. 'Raghavapuram Shale' is about 160′ thick and the topmost glauconitic band occurs at about 60′–70′ height from the bottom of the 'Shale'. This band is persistent and being comparatively harder than the associated sediments, stands out very much conspicuously in the scarp sections. There are one or two more similar bands below this. These bands may be either *in situ* or recently slipped from the top due to the plastic nature of the 'Shale' as suggested by King.[1] King[1] noticed only the topmost conspicuous band and described it to be an one-foot thick 'hard sandstone', occurring 60′ above the 'fine and buff shales' from the bottom. The bands are seen to vary in thickness from 6″ to 2′ and are mainly mudstones with occasional quartz grains of sand and silt size.

In the washed residues (− 40 + 200 mesh, A.S.T.M.) of these mudstones, the grains of glauconite are seen under the stereo-microscope to be isolated as dull green, well-rounded granules. These are found to be either embedded in the clay matrix of the coarse fraction (+ 40 mesh, A.S.T.M.) residues or to leave negative (void) impression on the mudstones.

Thin-section study reveals that these mudstones are full of olive to pale green, non-pleochroic to feebly pleochroic, microcrystalline mineral aggregates which are mainly of *sub-rounded habit*, low aggregate birefringence, low 2 v. with rarely one set of imperfect cleavage. Sometimes, the colour of the grains is found to grade to pale brown which is perhaps due to limonitisation. The periphery of the grain-aggregate is fractured.

As evidenced by the presence of pelecypod shells, ammonites and microforaminiferas, the 'Raghavapuram Shale' is mainly a marine deposit of Neocomian age (Spath[2]) and the occurrence of these grains is quite in keeping with this environment. What is striking here, in spite of the presence of microforaminifera, is the absence of any glauconitic mold of

micro-organism, particularly microforaminifera or 'foraminiferal' glauconite, as it is called, which establishes its marine origin beyond doubt. The glauconitic molds (after *Radiolaria* and *Nasselaria*) do occur in India in the Neocomian in the deep-water Giumal sandstones of the Tethys Himalayas (Krishnan[3]). 'Typical glauconitic rock', 'greensand' (Williams, Turner and Gilbert[4]) occurs in cretaceous in other parts of the world, too.

The author is grateful to the authorities of the Indian Statistical Institute for providing facilities for the field and laboratory work.

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METABOLIC RESPONSE TO OSMOTIC STRESS IN SOME FRESHWATER POIKILOTHERMS

THE utilization of metabolic energy for the osmotic performance in aquatic poikilotherms has been a subject of controversy for a very long time (*see* reviews 1 and 2). The increased metabolic rate in stress media has been attributed to an 'escape reaction'[3] and the consequent increase in the locomotor activity.[4] The euryhaline crab *Eriocher*[7] and the freshwater gastropod, *Theodoxus*[6] do not exhibit any change in the oxygen consumption in heterosmotic media. Potts[5] concluded that *Eriocheir* uses a negligible part of its metabolic energy for the osmotic work. However it has been shown in the crayfish,[7] brackish water prawn[8] and in *Palœmonetes varians*[9] that the O_2 consumption in various salinities is governed by the osmotic gradient existing between the blood and the medium. The present report reveals the relationship between the metabolism and the osmotic or ionic gradient which the animal sustains with the medium in four freshwater poikilotherms, the crab *Paratelphusd hydrodromous*, the common cattle leech *Hirudinaria granulosa*, the amphibious snail *Pila globosa* and the freshwater mussel *Lamellidens marginalis*.

The oxygen consumption was measured by the method adopted by Saroja.[10] Chloride content of the body fluids was estimated by Sendroy's method[11] and also by potentiometric

titration using a Gallenkamp electrometric microtitrator. Sodium was estimated with the help of a Carl zeiss flame photometer. Bargers's method was employed for the determination of osmotic pressure. In crabs and leeches respiratory measurements were carried out in a sequence in all the salinities using the same individuals after keeping the animals for 45 minutes in each medium. In shelled forms the animals were left for 4 days in each of the experimental media before the measurements were made. Blood or body fluid analysis was done in animals which have received the same treatment.

It is evident from Table I that the four organisms studied differ very much in their ability to regulate the water and salt balance in stress media. The crab is the most tolerant being able to withstand even the undiluted sea-water and the freshwater mussel is the least tolerant being unable to survive for long even in 20% sea-water. The leech and the snail occupy an intermediate position as far as the osmotic independence is concerned.

It is interesting that except in the freshwater mussel the rest of the species exhibited maximal oxygen consumption in their natural medium of freshwater. Similar observations on other freshwater animals have been reported.[7,12] In the case of crab the lowest O_2 consumption is seen in 50% sea-water, a medium which presents the minimal chloride gradient to the animal. In the marine crab *Ocypoda albicans*,[13] in the brackish water crab *Sesarma plicatum*[15] and in a freshwater teleost *Etroplus maculatus*[12] also

the O_2 consumption follows the chloride ion gradient. It is also seen in *P. hydrodromous* (Table I) that even though the general pattern of metabolic response to salinity is similar in both the seasons studied the magnitude of response is different in summer and winter. In *H. granulosa* the O_2 consumption is shown to follow the total osmotic pressure and the sodium concentration of the body fluids which are nearly isotonic with the medium when the leeches are in 25% sea-water. *Pila globosa* exhibits minimal O_2 consumption in 37.5% sea-water which is isotonic with the body fluids of the animal. In the freshwater mussel, the blood concentration of which is very low, the minimal O_2 consumption is in tap-water which incidentally offers the minimal osmotic gradient. It is clear from this study that there would be an elevation or depression in the total metabolism with the increase or decrease in the osmotic or ionic gradient, as the case may be, reflecting at least in part the energy expenditure for the osmotic work done. But there are cases like the marine populations *Metapenaeus monoceros*,[8] freshwater populations of *Potamopyrgus jenkinsi*[14] and the marsh pool individual of *Palaemonetes varians*[9] where the O_2 consumption is minimal in their natural medium despite the existence of a large osmotic gradient. This has been explained to be due to the operation of a metabolic homeostatic mechanism.[8] In the present investigation it is seen that except in leech which exhibits partial metabolic homeostatis (increase in metabolic rate in hypotonic media is less when compared to that in hyper-

TABLE I

Medium	Paratelphusa hydrodromous			Hirudinaria granulosa			Pila globosa		Lamellidens marginalis	
	Chloride mM/1 gradient (med.–bl.)	% basal of O_2 consumption taking the value in 50% S.W. as 100.. 27°C. Winter	35°C. Summer	Osmotic gradient (med.–bl.) % NaCl	Sodium gradient (med.–bl.) mM/l	% basal of O_2 consumption taking the value in 25% S.W. as 100. 30°C.	Osmotic gradient (med.–bl.) % NaCl	% basal of O_2 consumption taking the value in 37.5% S.W. as 100. 30–31°C.	Osmotic gradient (med.–bl.) % NaCl	% basal of O_2 consumption taking the value in T.W. as 100. 27°C.
Tap-water	−255.00	132.3	125.0	−0.455	−66.24	112.7	−0.485	241.5	−0.06	100.0
10% S.W.	..	..	..	−0.230	−36.80	105.2	−0.220	207.8	+0.11	122.2
20% S.W.	..	..	..	..	..	..	..	..	+0.22	77.8
25% S.W.	−106.11	117.7	108.3	+0.045	+5.00	100.0	−0.140	151.9	There is depression in the metabolism due to adverse effect in 20% sea water	
37.5% S.W.	−52.37	106.3	101.6	+0.213	+36.67	122.6	−0.075	100.0		
50% S.W.	+21.05	100.0	100.0	+0.550	+55.80	137.6	+0.180	122.1		
62.5% S.W.	+76.52	113.5	108.3	Fail to survive in higher concentrations			Do not survive in higher concentrations			
75% S.W.	+133.24	119.8	117.5							
100% S.W.	+281.26	127.1	118.3							

med. = medium; bl. = blood.

tonic media) and freshwater mussel which does not sustain a large gradient in freshwater, the other two animals (crab and snail) do not seem to be capable of any such metabolic homeostatis as is evident from their high O_2 consumption in freshwater.

But it might also be noted that the great decrease in the total metabolism that was observed in the isotonic media (*e.g.*, in *P. globosa* the O_2 consumption in tap-water is 250% higher than in 37.5% sea-water which is isotonic with the animal) may not entirely be a manifestation of decreased osmotic work, for some other factors which are yet to be understood may be causing such a decrease in the metabolism. Similarly in the marsh pool individuals of *P. varians*[9] the 600% increase in total metabolism between the isotonic medium and the extreme salinity may not entirely be a reflection of the work done due to osmotic effects.

I wish to record my thanks to Prof. K. Pampapathi Rao for his guidance.

Department of Zoology,   R. RAMAMURTHI.
Sri Venkateswara University,
Tirupati (A.P.), India, *December 19, 1964.*

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A NEW SPECIES OF *NODULISPORIUM*

A NEW species of *Nodulisporium*, *N. griseo-brunni* sp. nov., is described.

Nodulisporium griseo-brunni SP. NOV.

Coloniæ griseo-brunneæ diametrum attingentes 4 cm. post dies 8-10 in agaro Czapek. Hyphæ repentes irregulariter ramosæ numquam vero verticillatæ, ramulis iterum iterumque furcatis; conidiophori emergunt ut projectiones breviese ramulis lateralibus. Conidia terminaliter et lateraliter insidentia ramulis lateralibus.

Conidia globosa, quidem $3.8-7.6\,\mu$ diam., vel ellipsoide vero $6.8-9.88 \times 3-4.5\,\mu$.

Præsens species lecta in solo in hortu *Piperis betle* ad Saugor, M.P., India. Typus : Herb. IMI 80672.
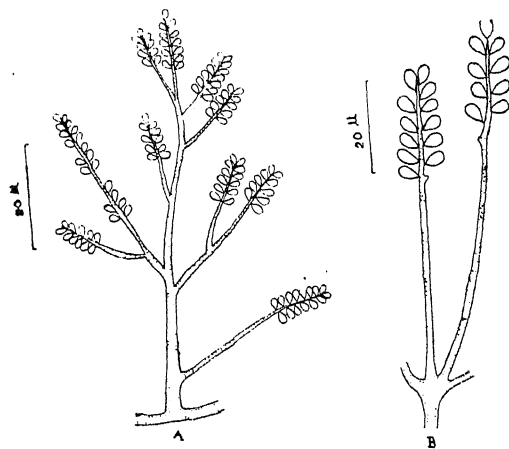
FIG. 1. A. A conidioyhore with conidia, × 70. P. Branches of conidiophore and conidia, × 300.

Nodulisporium griseo-brunni SPEC. NOV.
(FIG. 1, A AND B)

Colonies greyish-brown attaining 4 cm. diam. in 8-10 days on Czapek's agar. Repent haphæ irregularly branched but never in whorls, branches repeatedly branched, conidiophores arising as short projections of the side branches. Conidia borne laterally and terminally on the side branches. Conidia globose, $3.8-7.6\,\mu$ diam., or ellipsoidal $6.8-9.88 \times 3-4.5\,\mu$.

Isolated from a *Piper betle* orchard soil of Saugar, M.P., India. The culture has been deposited at the Commonwealth Mycological Institute, Kew, England as IMI 80672.

Department of Botany, .   R. S. MEHROTRA.
University of Saugar,
Saugar, M.P., *November 26, 1964.*

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A NEW SPECIES OF *SORDARIA*

DURING August 1962, a species of *Sordaria* was found associated with the fruits of *Prunus persica* Stokes. Detailed morphological studies indicated it to be different from all the known species of *Sordaria*. In the shape of the perithecia and asci the present isolate showed some resemblance to *S. bosensis* Das,[1] but differed on account of its rounded or oval ascospores, provided with fine gelatinous sheath. The present isolate is, therefore, described as *Sordaria indica* sp. n.

Sordaria indica SPEC. NOV.

Coloniæ in agaro maltoso 2% primo roseæ, tum luteolorubræ, patentes, mycelio æreo sparso. Hyphæ tenues, ramosæ, septatæ, 2·5–3·5 µ crassæ. Perithecia dispersa, distincta vel gregaria, superficialia, sphærica vel ovoidea, 155–315 µ diam., luteola, vestita pilis minutis septatis flexuosis. Peridium tenue et membranaceum. Asci octospori, cylindrici, recti vel vix curvi, 65–85 × 10–13 µ. Paraphyses nullæ. Ascosporæ 9·0–14·5 µ (med. 11·7 µ), uniseriatæ, uniguttulatæ, unicellulares, rotundæ vel ovales, singulæ ornatæ vagina tenui mucosa et unico germinationis poro, hyalinæ primo, ad maturitatem evadentes olivaceo-nigræ et nontranslucidæ.

In fructibus *Pruni persicæ* Stokes, in fructuum emporio ad Chowk, in Alladabad, mense augusto 1962. Cultura typica posita in Instituto Mycologico ad Hortum Kewensem, in Anglia sub numero IMI 100483.

Sordaria indica sp. nov.—Colonies on 2% malt agar at first pink, then yellowish-red, spreading
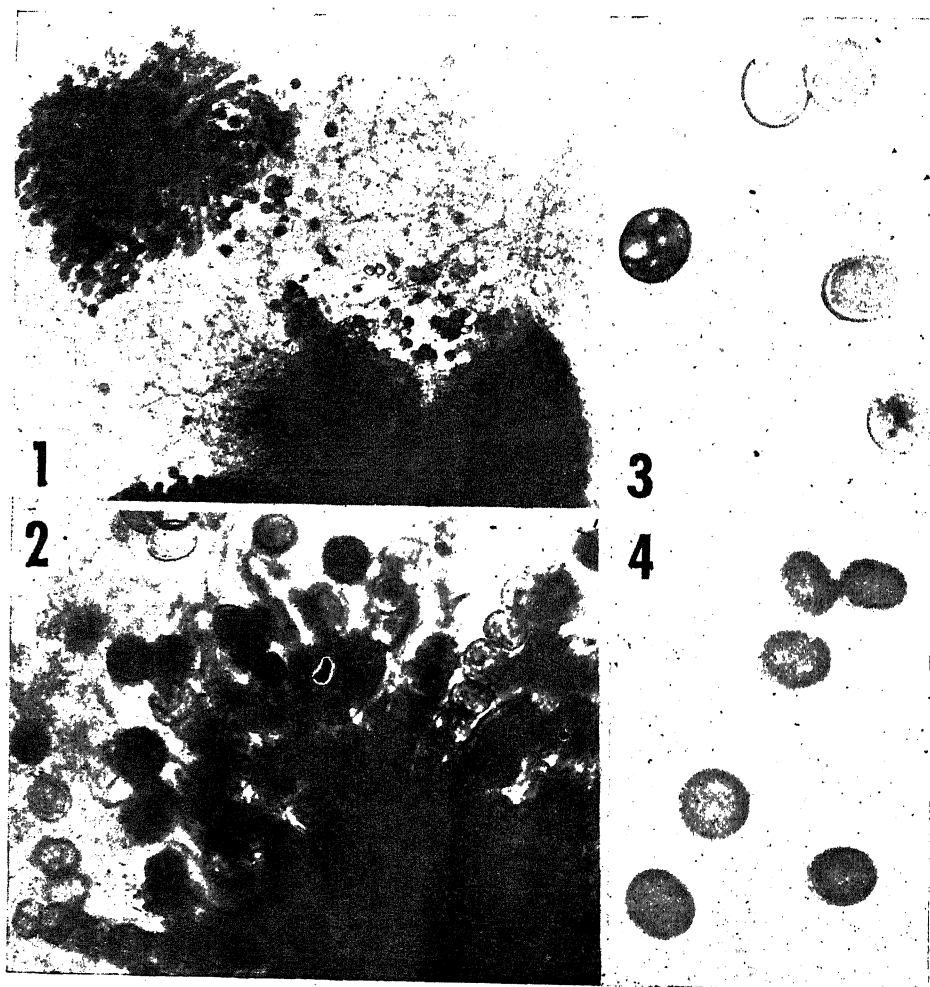
FIGS. 1-4. *Sordaria indica*. Fig. 1. Perithecium, asci and ascospores, × 200. Fig. 2. Asci, × 600. Fig. 3. Semimature ascospores showing gelatinous sheath, × 800. Fig. 4. Mature ascospores, × 700.

with sparse aerial mycelium. Hyphae thin, branched, septate, $2 \cdot 5 - 3 \cdot 5 \mu$ in thickness. Perithecia scattered, separate or gregarious, superficial, spherical or ovoid, $155 - 315 \mu$ in diameter, yellowish-brown in colour, covered with small septate flexuous hairs. Peridium thin and membranous. Asci 8-spored, cylindrical, straight or very slightly curved, $65 - 85 \times 10 - 13 \mu$. Paraphyses absent. Ascospores $9 \cdot 0 - 14 \cdot 5 \mu$ (mean $11 \cdot 7 \mu$), uniseriate, uniguttulate, one-celled, rounded or oval, each having a fine gelatinous sheath and a single very minute germ pore, hyaline when young, changing to olivaceous black and opaque at maturity (Figs. 1–4).

On fruits of *Prunus persica* Stokes, Fruit Market, Chowk, Allahabad, August, 1962. Type culture has been deposited at the Commonwealth Mycological Institute, Kew, England, Herb. No. IMI 100483.

Our grateful thanks are due to Dr. J. C. & Hopkins, Director and Dr. C. Booth, Assistant Mycologist, C.M.I., Kew, England, for their kind help in the identification of this species. We are also thankful to Rev. Fr. Dr. H. Santapau for rendering specific diagnosis into Latin.

Plant Pathological Lab.,   M. P. Srivastava,
Department of Botany,   R. N. Tandon.
University of Allahabad,
Allahabad, India, *November* 25, 1964.

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STUDIES ON THE EMBRYOLOGY OF *UTRICULARIA GRAMINIFOLIA*, VAHL.

THE genus *Utricularia* has 16 species in South India, out of which only four species have been worked out.[1-4]

The present investigation deals with the microsporogenesis, megasporogenesis, and the development of the embryosac in *Utricularia graminifolia*, Vahl.

The anther primordium arises as a homogeneous mass of cells which later become two lobed. A plate of hypodermal archesporial cells is differentiated (Fig. 1). The next stage shows primary parietal cells separating the sporogenous tissue from the epidermis (Fig. 2). The sporogenous tissue remains one-layered throughout. The primary parietal cells form three layers. Of these the outermost forms the endothecium and the innermost functions as the tapetum with a middle layer in between (Fig. 3). The middle layer degenerates very soon (Fig. 4). The tapetal cells are uninucleate in the early stages of development but become two to three-nucleate at later stages of microsporogenesis (Figs. 3, 4). A mature anther is four-lobed and shows the epidermis and the tapetal cells at various stages of degeneration. The endothecium in a mature anther shows fibrillar thickenings (Fig. 5). The microspore mother cells by meiotic divisions form microspore tetrads with tetrahedral, decussate and isobilateral arrangements (Figs. 4, 6). The pollen grains are triporate and show two nuclei of equal size at the time of shedding (Fig. 5). The exine is thick and smooth.

The ovary is superior, bicarpellary, syncarpous and unilocular with innumerable anatropous ovules arranged all along the massive central placenta. The ovules are placed one behind the other but at the apex they are seen to be back to back. At first the ovular primordia appear as small conical projections. Later due to unilateral growth they become anatropous. The ovules are tenuinucellate and unitegmic. Usually one hypodermal archesporial cell is differentiated (Fig. 7) but occasionally two archesporial cells are also found. The archesporial cell functions directly as the megaspore mother cell (Fig. 8). It undergoes the usual meiotic divisions resulting in the formation of a linear tetrad of megaspores (Fig. 9). The upper three megaspores degenerate and the chalazal one functions (Fig. 10) giving rise to an eight-nucleate embryosac (Figs. 11, 12, 13). The development of the embryosac thus corresponds to the Polygonum type.

The micropylar end of a mature embryosac protrudes out of the micropyle and lies in close contact with the placental nutritive tissue (Fig. 13). The micropylar end is globular while the chalazal end is tapering. The scanty nucellar tissue disorganises during the course of development, leaving the embryosac in close association with the integument, the cells of which become conspicuous and radially elongated functioning as the integumentary tapetum (Figs. 11, 12). The polar nuclei do not fuse but remain close to each other. The antipodals are small in size corresponding to the narrowness of the chalazal region of the embryosac.

Department of Botany,   Maqbool Begum.
Central College, Bangalore, *January* 9, 1965.
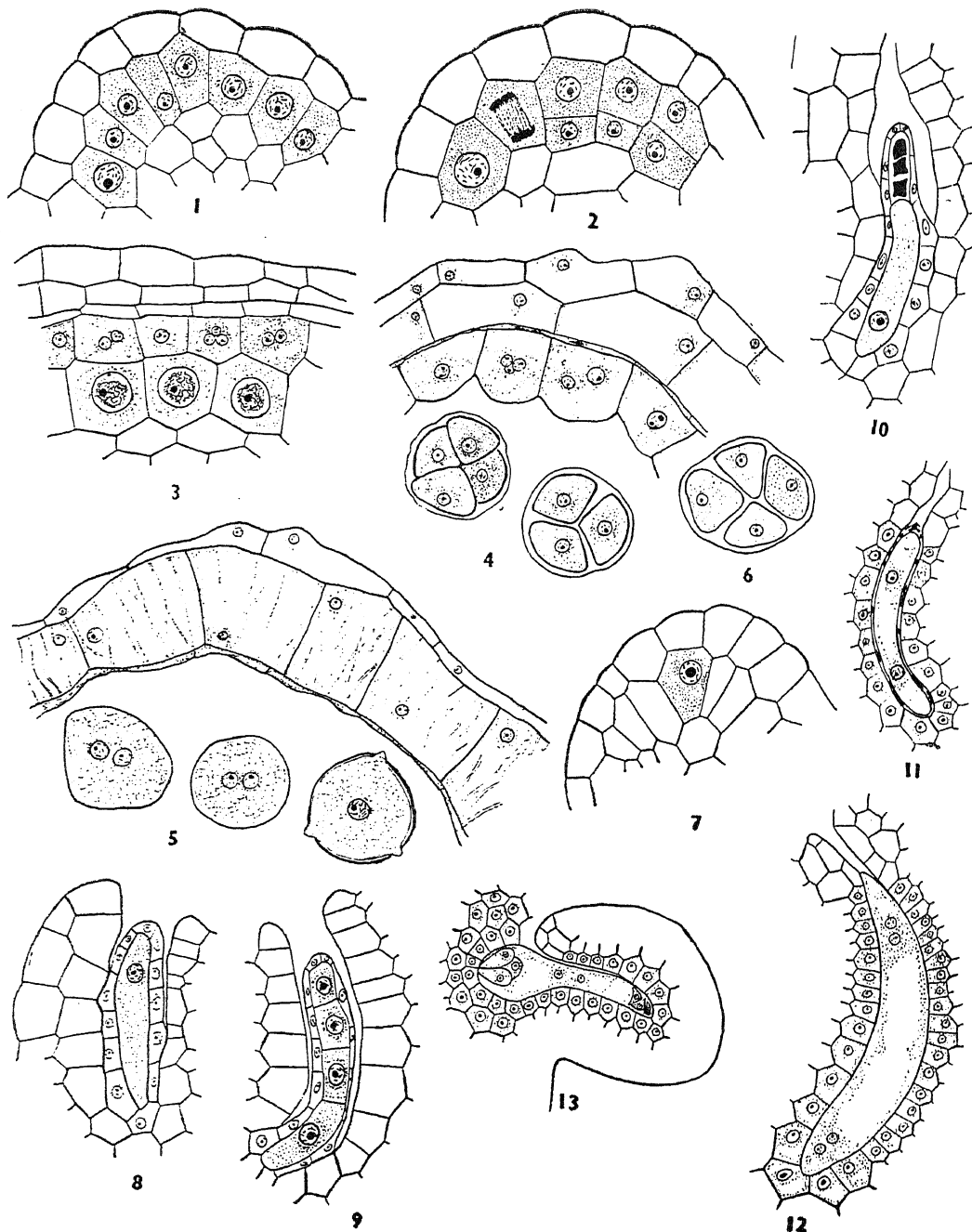
FIGS. 1-13. Fig. 1. Part of anther showing hypodermal archesporium, × 727·5. Fig. 2. The sporogenous tissue and the primary parietal layer × .27·5. Fig. 3. Part of anther showing the microspore mother cells, tapetal cells and the middle layers, × 727·5. Fig. 4. Microspore tetrads—Decussate and tetrahedral, × 727·5. Fig. 5. Endothecium showing fibrillar thickenings and two nucleate pollen grains. × 727·5. Fig 6. Isobilateral tetrad of microspores, × 727·5. Fig. 7. Archesporial initial, × 727·5. Fig. 8. Megaspore mother cell, × 727·5. Fig. 9. Linear tetrad of megaspores, × 727·5. Fig. 10. Functional megaspore, × 727·5. Fig. 11. Tow-nucleate embryosac, × 727·5. Fig. 12. Four-nucleate embryosac, with integumentary tapetum, × 727·5. Fig. 13. Mature embryosac with placental nutritive tissue, × 322·5.

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REVIEWS AND NOTICES OF BOOKS

Solar Plasma, Geomagnetism and Aurora. By S. Chapman. (*Documents on Modern Physics Series*) (Gordon & Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. 141. Price : Paper, $ 1.95 and Cloth, $ 4.95.

Professor Chapman's monographs were in-cluded in the volume on "Geophysics" issued by the same publishers which was reviewed in the July 20, 1964, issue of *Current Science* on page 444. This has now been reprinted separately under the title "Documents on Modern Physics", from *Solar Plasma, Geomagnetism and Aurora* for the convenience of readers and such avail-ability will be much appreciated.

C. V. R.

Silicate Science, Volume 1 : *Silicate Structures.* By Wilhelm Eitel. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. xii + 666. Price : Subscription $ 21.00 ; Regular $ 24.00.

The University of Chicago Press in the year 1954 published a book by the same author under the title *The Physical Chemistry of the Sili-cates.* Since then the subject has been vastly advanced and it is proposed to cover the entire field in its present state in a series of five volumes of which the present is the first. The subjects dealt with in the volume under review appear in three sections, *viz.*, Section A—Silicate Crystal Structures ; Section B—Clay Minerals, Structures ; and Section C—Silicate Dispersoids. Each of these is a great field in itself and is dealt with in a highly competent fashion. Ex-tensive references are given to the literature and these appear as footnotes practically on every page of the book. At the end of the volume, besides the author index and subject index, we find a compound index respectively for organic and inorganic compounds and a mineral index.

As silicates are of interest in many branches of pure and applied science, the present volume and its followers are sure to be widely welcomed.

C. V. R.

Selenium: Geobotany, Biochemistry, Toxicity and Nutrition. By Irene Rosenfeld and Orville A. Beath. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. xii + 411. Price $ 15.00.

The biological effects and pathological syn-dromes produced in animals by an excess or deficiency of selenium and its compounds are presented in this volume. The following is the list of the subjects dealt with in the successive chapters of this book : 1. Geological Distribution of Selenium ; 2. Selenium-Indicator Plants ; 3. Accumulation of Selenium by Plants ; 4. Selenium Poisoning in Animals ; 5. Preven-tion and Control of Selenium Poisoning ; 6. Sele-nium in Nutrition ; 7. Selenium in Relation to Public Health ; 8. Chemistry of Selenium ; and 9. Biochemistry of Selenium.

C. V. R.

The Direct Observation of Dislocations. *Supplement 6 of Solid State Physics.* Edited by F. Seitz and D. Turnbull. Author : S. Amelinckx. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. 487. Price $ 17.00.

Of particular value to electron microscopists working in the field of solids, this monograph presents a complete review of all known methods for detecting individual dislocations in solids under study. Mathematical deriva-tions are given in great detail, often in a form not previously published in order to allow readers with a limited mathematical training to follow the arguments.

Among the techniques discussed are crystal growth and evaporation, etching, decoration, decoration-etching, birefringence, X-ray diffrac-tion, electron microscopy and diffraction. In each case the theoretical background is deve-loped and its use is illustrated by specific, representative examples.

C. V. R.

Advances in Lipid Research, Vol. 2. Edited by Rodolfo Paoletti and David Kritchevsky. (Academic Press, New York and London), 1964. Pp. xi + 499. Price $ 16.00.

The first volume of this series was reviewed in *Current Science,* Vol. 33, page 693, 1964.

The subject-matter in the present volume is dealt with in eight chapters, the titles of which are as follows : 1. Triglyceride Structure, by R. J. Vanderwal ; 2. Bacterial Lipids, by M. Kates ; 3. Phosphatidyglycerols and Lipo-amino Acids, by Marijorie G. Macfarlane ; 4. The Brain Phosphoinositides, by J. N. Haw-thorne and P. Kemp ; 5. The Synthesis of

Phosphoglycerides and Some Biochemical Applications, by L. L. M. Van Deenen and G. H. de Haas ; 6. The Lipolytic and Esterolytic Activity of Blood and Tissues and Problems of Atherosclerosis, by T. Zemplényl ; 7. Evaluation of Drugs Active against Experimental Atherosclerosis, by Robert Hess ; and 8. Comparative Evaluation of Lipid Biosynthesis *in vitro* and and *in vivo*, by P. Favarger.

                                                      C. V. R.

Advances in Chemotherapy, Volume I. Edited by Abraham Goldin and Frank Hawking. (Academic Press, New York and London), 1964. Pp. xi + 579. Price $ 17.50.

This new series is designed to provide comprehensive, authoritative surveys of all fields of chemotherapy, emphasizing both theoretical and experimental aspects. Each review is a critical monograph synthesizing existing knowledge and pointing the way to new hypotheses.

The subject-matter in the present volume is dealt with in nine chapters as follows : 1. Historical Perspectives in Chemotherapy, by E. K. Marshall, Jr. ; 2. Mechanisms of Action of Phenanthridine and Aminoquinaldine Trypanocides, by B. A. Newton ; 3. Chemoprophylaxis and Chemotherapy of Viral Diseases, by Randall L. Thompson ; 4. The *Vinca* Alkaloids, by N. Neuss, I. S. Johnson, J. G. Armstrong and C. J. Jansen ; 5. Cell Culture and Cancer Chemotherapy, by G. E. Foley and S. S. Epstein ; 6. Immunoreactions in Antiparasitic Chemotherapy, by Frans C. Goble ; 7. Drug Synergism in Antineoplastic Chemotherapy, by John M. Venditti and Abraham Goldin ; and 9. New Concepts of the Use of Inhibitors in Chemotherapy, by Nathan O. Kaplan and Morris Friedkin.   C. V. R.

Mammalian Protein Metabolism, Volume II. Edited by H. N. Munro and J. B. Allison. (Academic Press, New York and London), 1964. Pp. xv + 642. Price $ 21.00.

Volume I of this treatise was reviewed in *Current Science*, Volume 34, page 63, 1965.

The material in the present volume is divided into two sections, *viz.*, the nutritional aspects and pathological aspects of protein metabolism. The first section contains six chapters as follows : 1. The Nutritive Value of Dietary Proteins, by J. B. Allison ; 2. Amino-Acid Toxicities and Imbalances, by A. E. Harper ; 3. Protein Requirements, by D. M. Hegsted ; 4. Protein Metabolism and Requirements in Pregnancy and Lactation, by K. L. Blaxter ; 5. Protein Meta-

bolism and Requirements in the Newborn, by R. A. McCance and Elsie M. Widdowson ; and 6. Protein Metabolism and Requirements in the Elderly, by Donald M. Watkin.

The second section also contains six chapters as follows : 1. Anomalies of Amino-Acid Metabolism, by L. E. Holt, Jr., and S. E. Synderman ; 2. Physical Injury and Its Effects on Protein Metabolism, by D. P. Cuthbertson ; 3. Protein Metabolism and Tumor Growth, by G. A. J. Goodlad ; 4. Experimental Protein-Calorie Deficiency, by B. S. Platt, C. R. C. Heard and R. J. C. Stewart ; 5. Clinical Aspects of Protein Malnutrition, by Fernando Viteri, Moisés Béhar, Guillermo Arroyave and Nevin S. Scrimshaw ; and 6. Protein Deficiency and Infective Disease, by Nevin S. Scrimshaw.   **C. V. R.**

The Bacteria—A Treatise on Structure and Function, Volume V : *Heredity*. Edited by I. C. Gunsalus and Roger Y. Stanier. (Academic Press, New York and London), 1964. Pp. xi + 517. Price : Regular $ 16.00 ; Subscription $ 14.00.

Reviews of the earlier volumes of this series have appeared in *Current Science* in previous years.

As remarked by the authors in the preface that in the year 1947, the dominant role that bacterial genetics would soon play in the formulation of our general concepts of heredity could scarcely have been foreseen by the most far-sighted or optimistic exponent of this new branch of genetics ; yet the connectoin has been so intimate that chapters on genetic fine structure, genetic replication mechanisms, and gene-enzyme relationships find a natural place in a volume devoted to the consideration of bacterial genetics.

The titles of the chapters contained in this volume and their respective authors are as follows : 1. Conjugation in Bacteria, by Julian D. Gross ; 2. Transduction, by Allan Campbell ; 3. Transformation, by Pierre Schaeffer ; 4. Bacterial Episomes, by Patrice Driskell-Zamenhof ; 5. Genetic Recombination in Streptomyces, by G. Sermonti and D. A. Hopwood ; 6. Genetic Fine Structure in Bacteria, by Royston C. Clowes ; 7. Molecular Aspects of the Gene : Replication Mechanisms, by Robert L. Baldwin ; 8. Gene-Enzyme Relationships, by Charles Yanofsky ; 9. Compositional Variation and Heterogeneity of Nucleic Acids and Protein in Bacteria, by N. Sueoka ; and 10. Toward a Definition of the Bacteria, by R. Y. Stanier.

                                                      C. V. R.

Nutrition—A Comprehensive Treatise, Vol. I: *Macronutrients and Nutrient Elements*. Edited by George H. Beaton and Earle Willard McHenry. (Academic Press, New York and London), 1964. Pp. xviii + 547. Price : Subscription $ 16.50 ; Regular $ 18.50.

This volume reviews current knowledge regarding the function and metabolism of the individual nutrients in man.

The treatise includes discussions of the role of nutrition in pregnancy, infancy, childhood, geriatrics, and dietetics. The factors affecting the choice of foods are considered, as well as the causes and prevention of malnutrition. Each topic is treated in depth and includes comprehensive documentation. Recent advances in knowledge are emphasized.

The subject-matter in this volume is dealt with in nine chapters. The following is the list of the titles of the chapters and their respective authors : 1. Regulation of Food Intake, by Jean Mayer ; 2. Carbohydrates and Fats, by H. M. Sinclair ; 3. Proteins, by D. M. Hegsted ; 4. Energy Metabolism, by R. W. Swift and K. H. Fisher ; 5. Calcium and Phosphorus, by Isabella Leitch ; 6. Iron, Copper and Cobalt, by W. W. Hawkins ; 7. Iodine, by John B. Stanbury and V. Ramalingaswami ; 8. Fluorine, by Gordon Nikiforuk and Robert M. Grainger ; and 9. Magnesium, by George K. Davis.

Research workers in the fields of nutrition, biochemistry, and physiology will find this treatise to be of great value, as well as university teachers and graduate students in these areas.

C. V. R.

Ultrasonic Cutting. By L. D. Rozenberg, V. F. Kazantsev, L. O. Makarov and D. F. Yakhimovich. (Published by Consultants Bureau Enterprises, Inc., 227 W, 17th Street, New York.) Pp. 142. Price $ 17.50.

Recent developments in engineering and technology have brought into use new materials, many of which are very difficult to work by conventional methods of machine working. To cite an example, the group of materials germanium, silicon, ferrites, ceramics, glass, quartz, etc., are brittle and they cannot withstand the forces needed for mechanical working. Methods of working such materials have been a problem and have led to new and special techniques. Ultrasonic cutting is one of them. Progress in this field has indeed been very rapid.

Ultrasonic cutting techniques are as yet far from perfected and they are only beginning to be exploited. The growing literature on the subject is, however, scattered and a concise but comprehensive account of the results so far achieved in ultrasonic machining or impact grinding, as it is called, will certainly be welcomed by workers in this field. This English translation of the original Russian text with numerous illustrations, machine drawings and designs fulfils this need, and deserves careful study.

A. S. G.

Essentials of Physics—Heat. By O. M. White. Pp. 211. Price 15 sh. ; *Electricity and Magnetism*. By O. M. White. Pp. 320. Price 20 sh. (Macmillan, St. Martin Street, London W.C. 2), 1965.

Essentials of Physics series published by Macmillan & Co., Ltd., will be in five parts : Heat, Light, Properties of Matter, Electricity and Magnetism, and Sound. Of the two titles that have come for review, *Heat* is the second edition specially revised for this series. Primarily written for schools in England to cover the advanced syllabus in Physics for the General Certificate of Education (GCE), the series can be recommended to Indian Universities for the Intermediate and Pre-University classes as well as to the Pre-Professional classes in Medicine, Engineering and Technology. The treatment is precise and the illustrations are clear. There are a number of worked examples and a good selection of examination questions.

A. S. G.

Nuclear Interactions of the Hyperons. By R. H. Dalitz. (Oxford University Press for the Tata Institute of Fundamental Research, Bombay), 1965. Pp. 106. Price Rs. 19·00.

Professor R. H. Dalitz gave a course of lectures at the Summer School in Theoretical Physics held by the Tata Institute of Fundamental Research, in 1961, at Bangalore. The present publication brings out in book form the principal contents of this course of lectures which was chiefly concerned with our present knowledge on the hyperon-nucleon interaction.

After giving a phenomenological analysis of binding energy data for hypernuclei, Prof. Dalitz among other topics discusses the optic dependence of the Λ-nucleon interaction, the hyperon-nucleon forces, and the Λ-N scattering and reaction processes. He also draws attention to a number of problems which will be of immediate future interest in this field of research.

A. S. G.

Exploding Wires, Volume III. Edited by William G. Chace and Howard K. Moore. (Plenum Press, 227 W, 17th Street, New York, N.Y.), 1964. Pp. 410. Price $ 17.50.

This latest volume reporting exploding wire phenomena contains 27 papers presented at the Third Conference on the title held at Boston on March 10-12, 1954. There are papers on theory, on shock waves, and on apparatus, instrumentation and methods of study. Particular mention may be made of the papers on exploding bridge wires (used to initiate high explosives) as the technique is of practical application in missiles and satellites. Mention may also be made of the paper on synthesis of inorganic binary compounds using the exploding wire technique.

A. S. G.

Proceedings of the International Conference on Cosmic Rays. Volume 3 : *Composition and Pre-History.* Pp. 510. Price Rs. 20·00. Volume 6 : *Muons and Neutrinos.* Pp. 251. Price Rs. 20·00 (paper bound). (Published by Tata Institute of Fundamental Research, Colaba, Bombay-5.)

The International Conference on Cosmic Rays, which was sponsored by the Cosmic Ray Commission of the International Union of Pure and Applied Physics and the Department of Atomic Energy, Government of India, was held for a fortnight in December 1963 at Jaipur, India. About 250 scientists from 30 countries participated in the Conference. There were 58 invited papers and 213 contributed papers.

The proceedings together with the general discussions, which took place at the end of each session, have been published in six volumes under the following subject headings : Vol. 1 : Solar Particles and Sun-Earth Relations ; Vol. 2 : Modulation ; Vol. 3 : Composition and Pre-History ; Vol. 4 : Extension Air Showers ; Vol. 5 : High Energy Interactions and Vol. 6 : Muons and Neutrinos.

With the issue of the two volumes 3 and 6 under review this series comes to a close. The earlier volumes were reviewed in these columns from time to time as they were published. Volume 3 contains 33 papers relating to composition of the cosmic rays, 12 papers relating to their origin, and 6 papers on their pre-history based on isotopic studies. Volume 6 devoted to Muons and Neutrinos contains 32 papers contributed by 52 authors.

As mentioned in the previous reviews the papers presented at the Conference are from working groups from different cosmic ray research centres spread all over the world and contain the latest researches and results on the subject. The editors are to be congratulated at the speedy manner they have been able to bring out the complete series by photo-offset method and make them available within about a year of the Conference.

A. S. G.

Books Received

Advances in Mathematics (Vol. 1, No. 2). Edited by H. Busemann. (Academic Press, New York), 1964. Pp. 103-264. Price $ 5.50.

Cloud Structure and Distributions over the Tropical Pacific Ocean. By J. S. Malkus and H. Riehl. (University of California Press, Berkeley, 2223, Fulton Street, Berkeley, California), Pp. 229. Price $ 7.50.

Carnegie Institution of Washington (Year-Book 63) (Carnegie Institution of Washington, 1530, P. Street, Northwest, Washington D.C. 2005), 1964. Pp. xi + 73 + 661. Price $ 1.50 (cloth bound).

Documents on Modern Physics—The Theoretical Significance of Experimental Relativity. By R. H. Dicke. (Gordon & Breach, Science Publishers, 50, Fifth Avenue, New York-11, N.Y.), 1964. Pp. xii + 153. Price $ 1.95 (paper back) ; $ 4.95 (cloth).

Group Theory and Solid State Physics (Vol. I). Edited by P. H. Meijer. (Gordon & Breach, New York-11), 1964. Pp. x + 293. Price $ 5.95.

Quantum Physics and Its Applications Series (Vol. I). *Group Theoretical Concepts and Methods in Elementary Particle Physics.* Edited by Feza Gursey (Gordon & Breach, New York-11), 1964. Pp. vii + 425. Price $ 19.50.

Final-State Interaction. By J. Gillespie. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. viii + 104. Price $ 6.95.

Interpretation of Metallographic Structures. By W. Rostoker and J. R. Dvorak. (Academic Press, New York), 1965. Pp. viii + 226. Price $ 10.00.

The Origins of Prebiological Systems and of Their Molecular Matrices. By S. W. Fox. (Academic Press, New York), 1965. Pp. xx + 482. Price $ 8.00.

Advances in Gerontological Research (Vol. 1). By B. L. Strehler. (Academic Press, New York), 1964. Pp. xi + 410. Price $ 13.50.

SCIENCE NOTES AND NEWS

Inactivation of Water-melon Mosaic Virus by Juice of *Portulaca grandiflora*

K. S. Bhargava and Rajendra Singh, Botany Department, University of Gorakhpur, Gorakhpur (U.P.), write:

Extracts from several plants are now well known for their inhibition of infectivity of plant viruses. While testing seventeen plant extracts against water-melon mosaic virus it was found that juice from *Portulaca grandiflora* has a powerful inhibitory effect. *Cucurbita pepo* L. var. *caserta* plant was used as a host for the systemic multiplication of the virus. The various treatments included (*i*) mixing of the plant juice with infective virus extract in equal proportions, and (*ii*) spraying the upper and lower surface of the host plant separately with the plant extract before inoculation with the virus. In all these treatments the juice of *Portulaca grandiflora* completely inhibited the activity of the virus. This extract withstood heating at 100° C. for 10 minutes and a dilution of 1 : 1000.

On the Occurrence of *Pestalotiopsis gracilis* (Kleb.) Stey. on *Ixora coccinia* L.

S. S. Prasad and Roy A. B. Verma, Department of Botany, Bihar University (L.S. College), Muzaffarpur, write:

During the course of survey of the phytopathogenic fungi of Muzaffarpur, we came across a new leaf-spot disease of *Ixora coccinia* L. during the months of March and April in the year 1964, from which we isolated *Pestalotiopsis gracilis* (Kleb.) Stey. Pathogenicity of the organism was established on the host by artificial inoculations. The lesions were restricted to the lamina forming isolated patches and in the beginning they appeared as light brown discolourations on both the surfaces of the leaves. The colour of the spots gradually changed from brown to ash-grey on the upper surface of the leaves, on which were situated the acervuli of the pathogen in the form of black dots.

The conidia were straight, often slightly curved and occasionally slightly constricted at the septa. They were five-celled of which the three central cells were deeply coloured, while the basal and apical cells were hyaline. The basal cell was provided with a beak and the apical one bore two to three setulæ. The conidia measured $18 \cdot 65–25 \cdot 43\,\mu \times 5 \cdot 9–7 \cdot 32\,\mu$.

As far as known to the authors *Pestalotiopsis gracilis* (Kleb.) Stey. has not so far been reported from this country on any host. The specimen has been deposited in the herbaria of the Commonwealth Mycological Institute, Kew, England (No. 108542).

An Aseptic Medium for Rearing the Rice Stem-borer *Proceras polychrysa* Meyr.

A. Perraju and K. Sivarama Krishnamurthy, Agricultural College, Bapatla, write:

The following composition of an aseptic medium was successfully used to rear larvæ of the rice stem-borer, *Proceras polychrysa* Meyr.: Agar, powdered 0·6 gm., Cellulose 0·5 gm., Sucrose 0·3 gm., Glucose 0·7 gm., Casein 1·0 gm., Cholesterol 0·2 gm., Choline chloride 0·2 gm., Rice plant (tender leaves and stem) 30·0 gm., Minerals 0·2 gm. and Water 40 ml.

Of the several compositions used by other workers this was found to be most suitable for rearing this rice-borer. Standard methods prescribed for sterilising medium and egg mass were adopted.

Evidence for "Weak" Force Interaction in Protons and Neutrons

Playing an important part in the sub-atomic world are two types of forces: the strong nuclear interactions which bind the nucleus together, and the weak interactions—10^{12} times weaker—which bring about the disintegration of the nucleus. Protons and neutrons interact through the "strong" force. The only particles definitely known to participate in weak interactions are neutrinos, electrons and several of the mesons. Feynman and Gell-Mann predicted several years ago that there should be felt "weak" force effect in interactions of protons and neutrons. At a recent meeting of the American Physical Society in Berkeley, F. H. Boehm and E. Kankeleit presented results of their observations which appeared to confirm this prediction.

The experiment was designed to examine the direction of spin of gamma-ray photons released in the decay of the radioactive isotope hafnium 181. This particular isotope was selected because protons and neutrons in its nucleus were

expected to produce the clearest evidence for a weak interaction, if one existed, for protons and neutrons. If there were no influence from a weak interaction, exactly half of the photons produced in the radioactive decay should emerge with a right-handed spin, and exactly half with left-handed spin. Evidence for the "weak" force would be found if the numbers were not quite equal ; this would indicate a violation of parity, which is permitted to nuclear events associated with "weak" forces.

The gamma-rays emerging from Hf (181) were sent through a large electromagnet, the polarity of which was reversed every 10 seconds. A large scintillation counter was suitably placed to count the photons received. The experiment determined for a large number of photons whether or not the polarity of the electromagnet had any effect on the number of photons reaching the counter. It showed that on the average left-handed and right-handed spin did not balance out for 3 out of every 10,000 photons. This was evidence that parity was not fully conserved and that the weak force was operative to a corresponding degree.—(*Scientific American*, February 1965.)

A Coherent Theory for Sub-Atomic Particles : $\tilde{U}$ (12) Theory

Professor Abdus Salam has presented a new theory that combines Einstein's special relativity with unitary symmetry SU (3)—the powerful technique for classifying the elementary particles within the nucleus. Although the extended SU (6) theory (see *Curr. Sci.*, May 20, 1965, p. 330) has been a notable achievement it still suffers from one fundamental and important disadvantage : it does not take into account the enormous speeds at which particles move about within the atomic nucleus. Consequently any exact theory of fundamental particles must also include the effect of Einstein's special theory of relativity. This is what has now been included by Salam and his colleagues in their $\tilde{U}$ (12)—"U-twelve-twiddle"—theory which is a logical extension of SU (3). Although much work remains to be done to solve the dynamical

predictions of $\tilde{U}$ (12), its immediate appeal is that it offers for the first time an exact and coherent theory for the classification of elementary particles.—(*Science Journal*, March 1965.)

Fine Structure of the Light Organ in Glow-Worm

Electron microscopical studies of the light organ of the glow-worm (*Lampyris noctiluca*) have revealed new information regarding the fine structure of the light organ which may help to correlate the fine structure with known biochemical reactions in light production by the organ. The studies were made on stained cut sections prepared from pieces of the abdominal segments 5 and 6 in female animals, fixed in potassium permanganate or osmium tetroxide solution. (Light organs in males are considerably smaller and inconvenient for use in this investigation.)

The light organ of *L. noctiluca* consists of four main parts, a transparent cuticle, a hypodermis, a photocyte layer several cells thick, and a single layer of cells comprising the reflector layer. Photocyte cells contain photocyte granules and a vesiculated reticulum. The reticulum is invaginated, forming vesicles of varying size and shape. Some of these vesicles contain structures that have the appearance of photocyte granules in the course of formation.

A hypothesis is that the photocyte granules are produced by the reticulum and then released into the general cell cytoplasm. The granules then release their own contents in some way and light production occurs. What the photocyte granules contain is purely conjectural ; for example, it could be a luciferin-luciferase complex.

The circumstantial evidence for the association of the reticulum with granule production, and hence light production, is that neither the granules nor the vesiculated reticulum are present in the reflector layer (dorsal cell layer), although there is a normal endoplasmic reticulum. It is possible that this unusual reticulum is peculiar to glow-worm light organs.—(*Nature*, 1965, 205, 1183.)

THE NEW PHYSIOLOGY OF VISION

Chapter XIX. Perception of Colour and the Trichromatic Hypothesis

Sir C. V. RAMAN

THE colouring of textiles with the aid of dye-stuffs is an art of great antiquity. The availability at the present time of synthetic dyes of varied sorts has greatly enlarged the range of the colours which can be fixed on textile fibres. In consequence, the student who desires to study dyed textiles has at his disposal sufficient material with which the entire field of colour could be covered. The present chapter records some observations made by the author on dyed silks with a view to determine the relationship between their perceived colour and the spectral character of the light which emerges from the material after escaping absorption in its interior. As the particular dye-stuff employed in the case of each specimen was unknown, the observations have been set out in the order of the colours exhibited by the material studied. These observations were intended to supplement those described in the preceding chapter in which the spectral character of the light transmitted by various colour filters was studied in relation to its perceived colour. The results were there set out separately for each of the materials used as a filter. They and the results obtained and reported here using a wholly different technique have been found to be completely in agreement.

The picture of the relationship between the perceived colour of polychromatic light and its spectral character which emerges from these studies bears no resemblance whatever to that envisaged by the so-called trichromatic theory of colour perception. It follows that the ideas underlying that theory are unsustainable. This aspect of the matter will be dealt with more fully as we proceed.

The Sensation of Purple. The purple dye with which the togas of the Roman Emperors were tinted was a very expensive material derived from a kind of shell-fish. A purple colour can however be readily produced with the aid of synthetic dyes. Indeed, purple silk is not infrequently adopted as the material for academic costumes. The author has in his possession three such costumes acquired at widely different dates. One is a full gown of purple silk, another a gown and hood of scarlet-coloured wool with facings of purple silk, and

a third is a gown and hood of scarlet silk, with the addition of an academic cap of a dark purple velvet with an inside lining and an outer edging of purple silk. The three samples of purple silk present somewhat different shades of colour. But on a spectroscopic examination, all showed in a very conspicuous fashion a common feature, *viz.*, that while the red, green and blue sectors in the spectrum were present in strength, the yellow of the spectrum was totally absent. There is a large drop in intensity between the green and the red sectors, the minimum being located at about 590 mμ. The purple silk edging in the third sample showed a well-defined dark band in the spectrum covering the spectral range between 580 mμ and 610 mμ.

The luminosity of the red sector relatively to those of the blue and green sectors varied as between the three samples. The full gown of purple silk which showed a violet shade of colour showed the blue sector of the spectrum more brilliantly than the other two. *Per contra*, the purple silk of the third sample, which exhibited a distinctly red shade of colour, exhibited the red sector rather more conspicuously in its spectrum. In every case, the green sector of the spectrum was conspicuous and was more luminous than the blue sector.

The behaviour of the three samples of purple-coloured silk demonstrates conclusively that the purple sensation has its origin in the suppression of the yellow sector of the spectrum by its absorption in the material, the blue, green and red sector continuing to be present in full strength, this being about the same in relation to each other as in white light. Deviations of the red-blue ratio from the normal value result in the exhibition of different shades of purple. We have here a clear contradiction with the ideas regarding colour embodied in the trichromatic theory of colour perception. According to that theory, the purple sensation is complementary to the green and arises from its absence. In other words, the more fully the green sector of the spectrum is extinguished, the deeper or more fully saturated would be the resulting purple sensation. So far from this being actually the case, we find that a fully saturated purple sensation is perceived despite the presence with undiminished intensity of the

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green sector in the spectrum of the light issuing from the material.

The Sensation of Blue.—Spectroscopic examination of a sample of blue silk showed a complete extinction of the yellow region in its spectrum. This extinction manifested itself as a dark band covering the wavelength range from 560 mμ to 590 mμ. The red sector of the spectrum also exhibited a notable diminution of brightness, as also a dark band crossing the spectrum and covering the spectral range from 620 mμ to 650 mμ. Despite these manifestations of absorption in it, the red sector of the spectrum was very far indeed from total extinction. The green sector of the spectrum in the wavelength range from 500 mμ to 560 mμ was also conspicuous. Though the blue sector showed an enhancement relatively to the green as compared with what is observed with white light, nevertheless the green sector of the spectrum as seen through the instrument was not less luminous than the blue.

Numerous other examples of blue silk were examined spectroscopically. In all cases, the yellow of the spectrum was powerfully absorbed and indeed except in the case of one sample which was of a light blue colour, it was quite inconspicuous. The red of the spectrum was also much weakened but never actually extinguished. The brightness of the green sector relatively to that of the blue sector varied from specimen to specimen. It could be stated as a general rule that the deeper the colour of the silk, in other words, the more nearly it approaches an indigo colour, the less was the intensity of the green sector relatively to that of the blue.

It is evident from these studies that an elimination, more or less complete, of the yellow sector of the spectrum is essential for the perception of a blue colour. Equally essential is a substantial reduction in the luminosity of the red sector. The part played by the green sector is less obvious. That a saturated blue colour is observed even though the green and red are conspicuously present in the spectrum can scarcely be reconciled with the assumption that the sensory impressions produced by polychromatic radiation represent a simple summation of the visual sensations excited by the different parts of it. Indeed, what we actually observe may be described as a masking of the visual sensations excited by the red and green sectors by that of the blue sector. It has, however, to be recognised that the progressive elimination of

the green sector by absorption results in the observed blue colour assuming a deeper hue.

The Sensation of Red.—A bright red colour frequently appears in the gorgeously coloured silk sarees for which Bangalore is famous. It was, therefore, possible for the author to examine numerous specimens of red silk spectroscopically. They all exhibited a remarkable effect, *viz.*, a dark absorption band covering the yellow of the spectrum and separating the red from the adjoining green in the spectrum. If the absorption band is absent, the colour of the silk is not red but either scarlet or orange as the case may be, depending on the proportion of yellow light escaping from the material. If, on the other hand, the absorption extends towards greater wavelengths, the colour of the silk is a darker red.

It is evident from these observations that the extinction of the yellow in the spectrum is an essential requisite for the material to exhibit a red colour. But what is particularly remarkable is that all the specimens examined exhibit the green and blue sectors in their spectra though with enfeebled intensity. It would appear that in these cases the sensation excited by the red sector of the spectrum results in a masking of the effects of the green and blue sectors by reason of their lower intensities.

The Sensation of Green.—Silk which has been dyed green exhibits a whole range of colours varying from what may be described as a light green at one end to a deep green at the other. Spectroscopic examination reveals that the appearance of even a light shade of green is accompanied by a weakening of both the blue and red sectors of the spectrum. Noticeable also is a fall in brightness of the range of wavelengths between 560 mμ and 600 mμ relatively to the wavelength range between 500 mμ and 560 mμ, in consequence of which the maximum of luminosity in the spectrum shifts visibly towards smaller wavelengths. These features are all accentuated in the case of the specimen exhibiting deeper colours, so much so that silk which appears a full green shows a nearly complete extinction of the yellow of the spectrum and the maximum of luminosity appears at 530 mμ. Silk which is of a deep green colour exhibits the maximum of luminosity at 525 mμ and the fall of the luminosity with increasing wavelength beyond 550 mμ is so marked that a dark band separating the green and the red in the spectrum is clearly recognisable. The blue of the spectrum is very weak and may be perceived extending beyond

the green towards shorter wavelengths. The red of the spectrum is also weakened but remains a conspicuous feature in the spectrum of even the darkest green silk. But it does not exert any observable influence on the perceived colour.

We may sum up by stating that an extinction of the yellow sector of the spectrum is essential for the material to exhibit a green colour. The red of the spectrum continues to be observable but is masked from perception by the more luminous green.

The Blue-Green Sequence.—Silk may be dyed so as to exhibit a whole range of colours which may be described as intermediates between green and blue. Spectroscopic examination reveals certain features common to the whole sequence and other features which exhibit a regular progression in the series. The common feature of the whole range of colours is a large fall in the brightness of the red sector as well as a practically complete extinction of the yellow sector. The progressive feature is the extension of the spectrum towards shorter wavelengths and the increase of the intensity of the blue sector. Remarkably enough, however, in all these cases, the green sector of the spectrum as observed through the instrument appears much more luminous than the blue.

Rose-Coloured Silk.—Of exceptional interest is the case of dyed silk which exhibits a rose-red hue which is both brilliant and attractive. Spectroscopic examination reveals that this colour has its origin in an extinction of the green sector of the spectrum, while the rest of the spectrum including, especially the blue sector, remains of undiminished intensity. That the colour resulting from this extinction of the green of the spectrum is a brilliant rose-red is a particularly significant fact. It presents us with a clear-cut contradiction of the ideas of the trichromatic theory according to which the sensation resulting from a suppression of the green in the spectrum should have been a highly saturated purple.

The Theory of Colour Perception.—The facts of observation set out above and in the preceding chapter enable us to form fairly clear ideas regarding the nature of the relationship which exists between the spectral character of polychromatic radiation and its perceived colour. It is also possible to go further and to venture upon an interpretation of the facts, basing ourself on a recognition of the corpuscular nature of light and the part that it plays in the percep-

tion of the colours of monochromatic radiation.

The spectrum of white light presents to our vision a continuous progression of colour in which we can distinguish a great many different hues. At some points in the spectrum, the progression of colour is exceptionally rapid and at others it is relatively slow. These experiences become intelligible when it is recalled that the energy associated with a light corpuscle increases progressively from one end of the spectrum to the other and that the perception of light arises from the absorption of the energy of the corpuscle and its transformation in the retina into the energy of electrical impulses which travel to the centres of perception. The variations of the luminous efficiency of radiation and of the power of colour discrimination in the spectrum arise as consequences of the spectroscopic behaviour of the visual pigments in the retina. Further, each different colour which we can perceive in the spectrum is "a fundamental visual sensation" and can claim recognition as such equally with every other colour in the spectrum.

It is the conjoint effect of the sensations excited by all individual parts of the spectrum of polychromatic radiation that determines its colour. By reason of the varying luminous efficiency of radiation in the spectrum, these individual contributions differ greatly, apart from the variations determined by the varying absorption in the material. Some sections in the spectrum may therefore be expected to contribute to the visual effect much more than others. In earlier chapters, factual evidence has been presented that the major visual sensations are those associated with the yellow sector of the spectrum. It is therefore not at all surprising and indeed could have been confidently anticipated that the removal of the yellow sector from the spectrum would result in notable chromatic effects and that the presence or absence of that sector would be the principal determining factor for the observed colour of the light. This, indeed, is what we actually find to be the case.

It is convenient in considering the colour sensations excited by polychromatic radiation to consider its spectrum to consist of four sectors : the blue sector from 400 mμ to 500 mμ ; the green sector from 500 mμ to 560 mμ ; the yellow sector from 560 mμ to 600 mμ and the red sector from 600 mμ to 700 mμ. We may ask ourself, what would be the result of removing the yellow sector from the spectrum of white

light, other things remaining the same. We have the blue and green sectors on one side and the red sector on the other side. What observation tells us is that the result is a purple sensation. We can therefore identify this sensation as the result of the superposition of the blue, green and red sectors, the yellow sector being absent. Observation likewise tells us that when the red is also weakened, even if it is not actually extinguished, the sensation perceived is blue. In other words, the observed sensation changes from purple to blue if the balance is tilted towards shorter wavelengths by lowering the intensity of greater wavelengths. If, further, the blue sector is much weakened, the sensation perceived is green, even though the red has not been totally extinguished. Thus, in every case, it would be seen that the perception of colour is determined by the domination or masking of the weaker by the stronger sensations. It is also evident from the facts that the blue and the green sectors are not antagonistic to each other, the perceived sensation arising from their co-operation being a blue or a green or an intermediate colour, according to the circumstances of the case. Other examples of transitional colours present themselves in the sequence of hues ranging from a pure yellow to a pure red through the intermediates of an orange-yellow, an orange and a scarlet.

The Trichromatic Hypothesis.—From the theoretical standpoint, each of the numerous distinguishable colours we can perceive in the spectrum is an independent visual sensation. The trichromatic theory of colours bases itself on the idea that the perceived colours of poly-chromatic radiation can be described in terms of "three fundamental sensations" and that these may be summed up making use of a set of empirically determined coefficients (positive or negative as the case may be) which vary from point to point over the spectrum. That the procedure is highly artificial is obvious, and its claim to acceptance disappears when the basic idea and its consequences are found to be flatly contradicted by the facts of observation. As we have seen, the circumstances in which polychromatic radiation actually presents itself to our perceptions as exhibiting such readily recognisable colours as purple, blue, green and red are very different from those contemplated by the trichromatic hypothesis.

One of the reasons for this failure of the trichromatic hypothesis stands out clearly. That hypothesis regards red, green and blue as the major visual sensations and relegates the sensation of yellow to a minor and secondary or derivative position. Actually, it is yellow which is the major visual sensation, while the red, green and blue though more colourful are only its subsidiaries. They are perceived as full colours only when the yellow is put out of the way.

CHEMICAL REACTIONS BY LASER LIGHT

WITH the advent of the laser the observation of 'two-photon' absorption processes at optical frequencies has become possible. Y. H. Pao and P. M. Rentzepis of the Bell Telephone Laboratories have reported experiments where this effect has been used for the first time to induce a specific chemical reaction. By irradiating a sample of distilled styrene monomer with light from a pulsed laser they succeeded in obtaining polystyrene. The sample was kept at the temperature of liquid nitrogen (− 192° C.) to stabilize free radicals released during the process. Following irradiation by a succession of some 20 laser pulses, the sample was warmed to room temperature when the polymer was precipitated. An infra-red spectrum analysis showed the precipitate to be identical to the known polymer, polystyrene.

Monochromatic light from ruby laser has a wavelength 6948 Å which is equivalent to a quantum of energy 1·8 eV. Ordinarily, photon of this energy cannot be absorbed by styrene monomers to induce chemical reaction. However, when an intense laser beam interacts with the molecular system, pairs of photons are absorbed almost simultaneously to excite the monomer molecule by 3·6 eV. This in turn causes the formation of free radicals and induces polymerization.

It is pointed out that the 'two-photon' absorption process proceeds in two stages by means of transient intermediate or 'virtual' states of molecules whose energies are about 1·8 eV and whose lifetimes are of the order 10^{-13} or 10^{-14} seconds only. These short-lived states become significant only under very high photon flux when transitions from them to the final state (of about 3·6 eV) may be induced. The authors believe that the experiment demonstrates a general phenomenon and that other multiphoton reactions may be induced by laser light.— (*Applied Physics Letters,* March 1, 1965.)

POGONOPHORA FROM THE INDIAN SEAS *

E. G. SILAS

Central Marine Fisheries Research Institute, Ernakulam Substation, Ernakulam-6

INTRODUCTION

PHYLUM Pogonophora is generally placed in the assemblage of enterocoelous coelomates (Echinodermata-Hemichordata-Chordata Stem) combined by some authors under the name Deuterostomia (Beklemishev, 1944; Ivanov, 1955 a, c, 1956, 1960, 1963; De Beer, 1955; Petrunkevitch, 1955; Abrikossov, 1957; Alvardo, 1957; Marcus, 1958; Hyman, 1959; Southward, 1963; and others). The apparent resemblance of Pogonophora to tubicolous Polychæta to which stress was laid by Hartman (1951, 1954) has been explained by Ivanov (1956) as being of only superficial nature brought about by convergences attributable to a similar mode of life in a tube. The enterocoelous mode of formation of the coelom, the trisegmental composition of the body, the presence of an unpaired dorsal nerve cord, the absence of ventral nerve cords, the presence of the heart, the pericardial sac, the pair of coelomoducts in the first segment, the pair of gonads in the third segment and the development of a rudimentary metameric arrangement within the elongated third segment have been given by Ivanov (1956) as characters of sufficient importance to justify the inclusion of Pogonophora in the Deuterostomia. In addition, Ivanov (1956) and Southward (1963) have drawn attention to the homogeneous nature of the group, which earlier Hartman (1954) had considered to be a heterogeneous assemblage of aberrant Polychæta which ".... may in time find their affinities with several families of sedentary polychætous annelids". Based on the numerous works of Ivanov (1949-63), and recent discoveries, Southward (1963) summarised that the questions that have aroused most interest in the study of Pogonophora are "The position of the group within the animal kingdom; the means of nutrition, since the alimentary canal has not been found; the dorso-ventral orientation of the animal", and in addition, "The problem of antiquity of Pogonophora has appeared as an argument in the continuing controversy about the age of the abyssal fauna" as may be found in the discussions on the subject given by Bruun (1957), Menzies and Imbric (1958) and Zenkevich and Brishtein (1960).

POGONOPHORA FROM THE INDIAN SEAS

In February-March, 1965 during the 71st and 72nd fishery cruises of the Indo-Norwegian Project Research Vessel *VARUNA*, while conducting deep-water exploratory bottom fishing operations along the continental shelf edge on the south-west coast of India between Cochin and Karwar, I was able to obtain specimens of Pogonophora from depths between 200 and 340 meters in the area off Cannanore-Mangalore. Some of the almost transparent chitinous tubes are broken, but the longest complete tube is 54 cm. long and has a diameter of 1·9 mm. at its mid-length. The paired elongate cork-screw-shaped tentacles in the specimens indicate that the specimens belong to the genus *Diplobrachia* Ivanov, 1960 (Family Polybrachiidæ Ivanov, 1960 of Order Thecanephria Ivanov, 1955). A description of the species, as well as details of associated organisms; temperature, salinity, oxygen and nutrient constituents of the water above the bottom from where the collections have been made; and a granulometric analysis of the sediments from which the tubes have been collected will be dealt with elsewhere.

The discovery that Pogonophora occurs along the continental shelf edge along the west coast of India may be of interest as these animals on account of the want of alimentary canal are known to occur in areas where there is concentration of suspended organic substances in the bottom layers, where the bottom current and the sea-floor relief may also be characteristic (Bruun, 1957; Kirkegaard, 1958; Southward, 1963). Savilov (1957) classed Pogonophora as detritus collecting forms, while Sokolova (1959) considered them as suspension feeders. Actual mode of obtaining food has not been observed, but different suggestions made as to the mode of feeding of these animals are: filtration of the suspended matter by the multi-tentaculate forms (Ivanov, 1955 b); collection of food from surface of deposits with the help of some sticky secretion (Southward, 1963); and the possibility of a relationship with bacteria to provide a source of soluble food (Jagersten, 1957).

The records of Pogonophora from the three major oceans of the world during the last ten years have disproved that extant Pogonophora are but relics of a group of animals which

flourished in all the oceans at some distant past. Besides drawing attention to the occurrence of pogonophorans in the continental shelf edge off our coast, this note is also aimed at giving a few pointers to would-be collectors.

The chitinous, almost transparent, tubes (banded dark and light in some, such as species of *Siboglinum* spp.) showing markings resembling annulations should be looked for in dredge and grab samples which may also contain tubes of Polychæta. Each tube will have a single animal and in the present material, they are found contracted, lying in the posterior half of the tube. In *Diplobrachia*, the free end of the tube can be easily identified as it invariably has polyzoans attached to it and in many tubes in the collection, a tubicolous polychæte is present in a separate fibrous tube adhering to one side. The polychæte tube is short, not more than 7 cm. long and is invariably encrusted with sand and shell bits. Such encrustations with epibionts are apparently met with in most pogonophoran tubes at the free end except in species of *Siboglinum* which have their tubes completely buried in the mud.

It is also likely that pogonophorans may occur in shallower waters of the continental shelf as at least one species, *Siboglinum caulleryi* Ivanov, 1957 *a*, has been collected from 22 meters from the Okhotsk Sea.

been found that if the tubes are merely placed in the preservative (formalin) the specimens are liable to be damaged, as the thick slimy substance in the tube where the contracted animal lies as well as the air pockets in the different parts of the tubes may prevent the easy penetration of the preservative to reach the animal tissues. It may be necessary to remove the animal from the tube and preserve it.

LIST OF KNOWN POGONOPHORA FROM THE INDIAN OCEAN

The first record of Pogonophora from the Indian Ocean was in 1960 when *Diplobrachia belajevi* was described by Ivanov collected from 580 meters depth east of Rodriguez Island. Since then, eleven more species belonging to four genera have been described by Ivanov (one in 1961 *a* and ten in 1963). To facilitate reference, these are listed below :

Phylum Pogonophora Johansson, 1937
  Class Athecanephria Ivanov, 1955
    Family Siboglanidæ Caullery, 1914
      Genus *Siboglanioides* Ivanov, 1961 *b*
        1. *S. dibranchia* Ivanov, 1961 *b*
            (From Timor Sea at 2080 m depth ; south of Bali Strait at 2810 m ; and Arabian Sea at 3275 m).
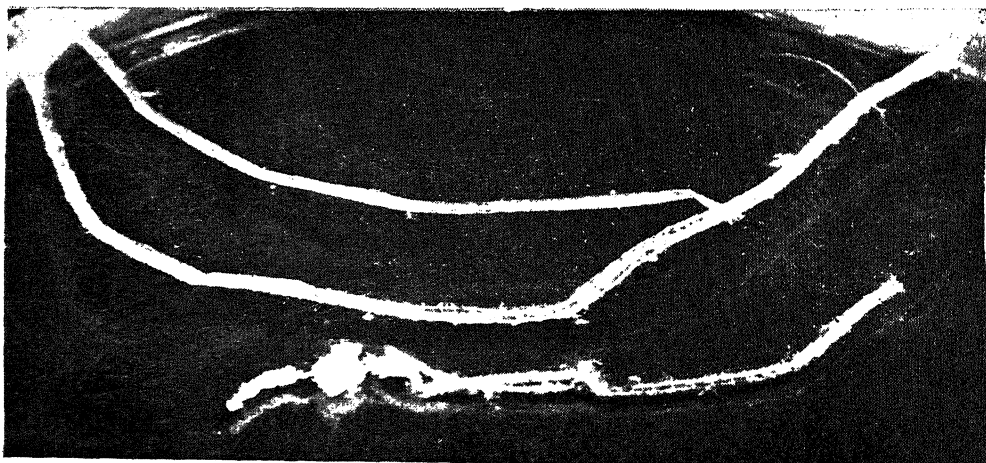
FIG. 1. Photograph showing a tube of the pogonophoran *Diplobrachia* sp., with the animal taken out in the foreground. (The anterior part of the animal—on the left side of the photo—is partly damaged), × 1.

In the accompanying photograph (Fig. 1) a tube of *Diplobrachia* sp. in the collection is shown along with a partly damaged specimen taken out of the tube. From experience it has

Genus *Siboglinum* Caullery, 1914 :
    2. *S. arabicum* Ivanov, 1963
        (From north of Socotra Island at 3285 m).

3. *S. ceylonicum* Ivanov, 1963
   (From west of Ceylon between 1920—2970 m).

4. *S. concinnum* Ivanov, 1963
   (From east of Zanzibar at 802 m).

5. *S. exile* Ivanov, 1963
   (From south of Sumatra at 626 m).

6. *S. silone* Ivanov, 1963
   (From Gulf of Aden at 900 m; and west of South India at 1300 m).

7. *S. subligatum* Ivanov, 1963
   (From north of Mauritius at 1740 m).

8. *S. Sumatrense* Ivanov, 1963
   (From south of Sumatra at 626 m).

9. *S. zanzibaricum* Ivanov, 1963
   (From east of Zanzibar at 2172 m).

Order Thecanephria Ivanov, 1955
Family Polybranchiidæ Ivanov, 1960
Genus *Diplobrachia* Ivanov, 1960

10. *D. belajevi* Ivanov, 1960
    (From east of Rodriguez Island at 580 m).

11. *D. Southwarde* Ivanov, 1963
    (From west of South India at 1300 m).

Family Lamellisabellidæ Uschakow, 1933
Genus *Lamellisabella* Uschakow, 1933

12. *L. minuta* Ivanov, 1963
    (From west of South India at 1300 m).

From the depth distribution of the known species from the Indian Ocean it will be evident that the present collections from 200 to 340 m. represent the shallowest depths from which Pogonophora have up to now been collected from this Ocean as all other species have been taken from waters deeper than 580 metres. The extremely patchy distribution of Pogonophora is mainly on account of their not having a mobile or free-swimming stage in the life-history. As Southward and Southward (1963) have suggested, there may be some association between the great abundance of Pogonophora in some areas "and an imbalance in the production cycle of plankton in the waters above, caused by upwelling, with consequent organic enrichment of the bottom deposits". On the west and east coasts of India, areas of upwelling are known during certain seasons, and

it is likely that these areas may sustain populations of Pogonophora at the bottom.

The phylum is represented in all the oceans including the Arctic and Antarctic. The described species stand at slightly over 70 belonging to 15 genera. Professor A. V. Ivanov's contribution to the advancement of knowledge regarding this group can be gauged from the fact that over 52 species have been described by him in addition to adding valuable information on the morphology, histology and embryology of several species. For a list of the described species and unnamed records reference is invited to Southward (1963).

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ADDENDUM

Since this note went to press, I have been able to collect more material of Pogonophora from the continental shelf along the south-west

coast of India between Quilon and Mangalore. Specimens of both the genera *Diplobrachia* and *Siboglinum* were obtained during the 75th Fishery Cruise of the Indo-Norwegian Project Research Vessel *VARUNA* from depths as shallow as 9 metres between Quilon and Cochin. I am told by fishermen who were shown the empty tubes of pogonophorans that during the south-west monsoon large quantities of empty tubes are washed ashore along certain beaches and this is not in the least surprising as the animals are found in dense congregations in certain areas close to the shore. Two points of interest are the occurrence of Pogonophora in very shallow waters of the littoral zone, and the apparent correlation in its occurrence in the continental shelf area and the areas of mud-bank formation and shrimp fishing grounds, along the south-west coast of India. Detailed investigations are under progress.

17th *May* 1965.   E. G. SILAS.

ORIGIN OF *AMARANTHUS DUBIUS*

MOHINDER PAL AND T. N. KHOSHOO

National Botanic Gardens, Lucknow (India)

*A*MARANTHUS DUBIUS Mart. ex Thellung, though indigenous to tropical North America, has spread with man throughout tropics where it is used for its grain and as a vegetable.[1] In India its introduction seems to be recent, since it is neither recorded by Hooker,[2] nor is mentioned in any of the regional floras.[3-7] However, it is a popular pot herb and has now become an escape in and around Lucknow where it is fast becoming a weed. Haploid chromosome number of the species is 32 (Fig. 2) and is the only natural tetraploid species reported so far in the genus.[8]

On the basis of his studies on F_1 *A. dubius* × *A. spinosus*, Grant[9] postulated that *A. spinosus* Linn. is one of the parents of *A. dubius*. We have not only studied a large number of individuals of the above hybrid ($2n = 49$), but also the ensuing amphiploid ($2n = 98$). In the light of our cytogenetic studies together with morphological comparison between the taxa concerned, the foregoing suggestion of Grant,[9] regarding the role of *A. spinosus* in the origin of *A. dubius*, has been examined here.

Studies on a number of populations of *A. spinosus* and *A. dubius* reveal the presence of 17 (Fig. 1) and 32 (Fig. 2) bivalents respectively in pollen mother cells. Fertility in both is normal. The F_1 hybrid *A. dubius* × *A. spinosus* arises spontaneously wherever and whenever the two species grow in sufficient proximity. These individuals possess $2n = 49$ and at metaphase I more than 50% pollen mother cells show $17_{ii} + 15_i$ (Fig. 3). While bivalents disjoin normally, univalents are distributed irregularly. Fertility is about 4%. In strong contrast to F_1, the amphiploid regularly forms 49 bivalents (Fig. 4) with an occasional loosely associated quadrivalent. Further course of meiosis and fertility are normal.

The formation of 17_{ii} in F_1 is the result of pairing between *spinosus* genome ($n = 17$) and 17 chromosomes (out of 32) of *A. dubius*, leaving the remaining 15 *dubius* chromosomes unpaired. The presence of 17_{ii} in the hybrid would ordinarily indicate that in *A. dubius* 17 chromosomes are homologous with the *spinosus* genome of $n = 17$. On this basis, Grant made the suggestion that *A. spinosus* is one of the parents of *A. dubius*. However, this suggestion is not supported by the situation found in the amphiploid *A. dubius-spinosus* ($n = 49$). In case the 17 bivalents of F_1 hybrid were organized between homologous chromosomes, then one should have encountered a high number of quadrivalents in the amphiploid. Far from a corresponding number of quadrivalents in the amphiploid, we found at the most just one quadrivalent and that too loosely associated. Therefore the 17 bivalents in F_1 are between homologous chromosomes, and evidently there ensues 96% sterility because of the disharmonious combinations resulting from differentially homologous chromosomes coupled with the irregular distribution of univalents. On the other hand, amphiploid is fertile because of the preferential pairing between the entirely homologous chromosomes followed by regular disjunction.

It emerges from the above that the genome of *A. spinosus* and the chromosomes of *A. dubius*, that pair with it, are not identical with each

other. As such *A. spinosus* in the present form does not appear to be one of the parents of *A. dubius,* unless we assume that after its entry

comparisons (unpublished data) we are inclined to look to the origin of *A. dubius* through alloploidy based on $16 + 16$, rather than $16 + 17$

FIGS. 1–4. *Amaranthus spinosus* = 17_{II}. Fig. 2. *A. dubius* 32_{II}. Fig. 3. F_1 Hybrid *A. dubius* × *spinosus* $17_{II} + 15_I$. Fig. 4. Amphiploid *A. dubius-spinosus* 49_{II}. All, × 1,160.

in *A. dubius,* the *spinosus* genome underwent radical alterations. Even after such an assumption, one more point requires solution. If *A. spinosus* ($n = 17$) is one of the parents of *A. dubius* ($n = 32$), it naturally implies that the other parent should have $n = 15$ (equivalent to the number of univalents in the F_1), a number not recorded so far in any of the species of the genus *Amaranthus.* However, Grant[9] is of the view that the other parent involved was also with $n = 16$ or 17. According to him the resulting amphiploid, with $n = 33$ or 34, got reduced by aneuploidy to $n = 32$, the number found in the present-day *A. dubius.*

It is apparent that *A. spinosus* ($n = 17$) and *A. dubius* ($n = 32$) belong to two different basic numbers, former to $x = 17$ and latter to $x = 16$. Furthermore, in the light of the cytogenetic evidence presented here and morphological

or $17 + 17$ followed by aneuploidy. We are trying to verify this suggestion experimentally.

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LETTERS TO THE EDITOR

ON THE MEASUREMENT OF PHOTO-ELECTRIC CROSS-SECTION OF GAMMA-RAYS

THE measurements of photoelectric cross-sections of gamma-rays reported so far have been made by one of the following methods : (a) By subtracting from the total absorption cross-sections, the calculated contributions of other competing interactions, e.g., Compton effect and pair production[1]; (b) By measuring the intensity of the photoelectrons[2,3]; (c) By comparing the intensities of the external-internal conversion electrons.[4,5]

We have measured the photoelectric cross-section of 662 Kev gamma-rays for K-electrons in lead by measuring the intensity of K radiation following the interaction and report the results in this paper. This method though indirect is relatively simpler and has wider applicability.

The 662 Kev gamma-rays from a 5 mC source of Cs[137] were allowed to fall on a thin foil of lead kept on the top of the NaI (Tl) crystal of a scintillation gamma-ray spectrometer. Both the lead foil and NaI (Tl) crystal were of the same diameter (25 mm.). The distance between the source and the target was about 35 cm.

The spectrum of the radiation emerging from the lead foil was scanned around the region of 76 Kev (weighted mean of the energy of K radiation of lead) and was found to contain K peak of lead on a continuum due to scattering. In order to isolate the contribution of X-rays, the lead foil was replaced by an equivalent aluminium foil matched to give the same scattering continuum. The difference between the lead and aluminium spectra gave the contribution of X-rays. The total number of K quanta produced in the lead foil was calculated from the observed contribution after taking into account the correction for iodine escape peak in the crystal,[6] photo-peak efficiency of the crystal, angular distribution of X-rays, the absorption in the lead foil and the solid angle subtended by the foil on the crystal. Isotropic angular distribution of X-ray emission was assumed and the solid angle was determined experimentally by moving a small Hg[203] source in place of the scatterer. Internal conversion line of Hg[203] (70 Kev) was used

for solid angle determination. The number of 662 Kev gamma-rays falling on the foil was determined by measuring the counts in the photo-peak of the direct spectrum when the foil was removed, and dividing it by photo-peak efficiency of the crystal. In order to obtain the number of 662 Kev gamma-rays actually responsible for the interaction, a correction for their absorption in the foil was applied. A mean value of $0 \cdot 40 \pm 0 \cdot 03$ was found as the interaction probability (P) per unit thickness of lead foil from five independent runs using different thicknesses of lead foils by comparing the number of X-ray quanta produced and number of gamma-rays actually responsible for the interaction.

Knowing the probability of interaction the cross-section (σ) for the production of fluorescent X-rays as calculated from the relation $P = \sigma n$ came out to be $12 \cdot 0 \pm 0 \cdot 9$ barns/atom. In this relation n is the number of atoms/c.c. of the target. The measured cross-section has to be corrected to take into account the de-excitation which takes place through the emission of Auger electrons[7] before it can be compared with the theoretical calculations of photo-electric cross-section. The fluorescent yield at 662 Kev for lead being $0 \cdot 965$ the measured photoelectric cross-section becomes equal to $12 \cdot 4 \pm 0 \cdot 9$ barns/atom, which compares favourably with the value of $12 \cdot 5$ barns/atom as obtained by the recent theoretical calculations of Pratt et al.[8] and of $12 \cdot 4$ barns/atom of NBS Circular.[1]

Physics Department,   R. S. OBEROI.
Punjabi University,   RADHE MOHAN.
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MEAN AMPLITUDES OF VIBRATION : XY₃Z TYPE OF SILICON COMPOUNDS

THEORETICAL studies regarding the normal vibrations of XY_3Z type molecules have been carried out by some authors.[1-8] In the present work evaluation of the mean amplitudes of vibration for some silicon compounds of this type has been done. The type of molecules studied here comes under the C_{3v} point group

Planck's constant, k is Boltzmann's constant and T is the temperature in degrees Kelvin.

The molecular parameters and frequencies used in the present investigation are given in Table I. The mean amplitudes for the bonded and non-bonded distance deviations and bending mean amplitudes are presented in Table II.

TABLE I

Molecular parameters and frequencies (cm.⁻¹) for XY₃Z type silicon compounds

Molecule	r Å	R Å	a_1 species			e species			Ref.
			σ_1	σ_2	σ_3	σ_4	σ_5	σ_6	
SiD₃H ..	1·480	1·480	2182	1573	851	1593	683	683	9
SiH₃F ..	1·460	1·595	2206	990	872	2196	943	728	10
SiH₃I ..	1·480	2·450	2192	903	355	2206	941	592	11
SiF₃H ..	1·564	1·479	2315	859	425	999	845	305	12
SiF₃D ..	1·564	1·467	1688	854	422	994	629	302	12
SiCl₃H ..	2·010	1·550	2257	489	249	798	587	179	8
SiBr₃H ..	2·190	1·550	2236	362	166	770	470	115	8
SiBr₃Cl ..	2·190	2·010	579	288	159	498	173	101	13
SiI₃Cl ..	2·020	2·450	557	220	114	411	134	73	14
SiCl₃Br ..	2·050	2·190	545	368	191	610	205	135	13
SiCl₃I ..	2·450	2·020	519	333	169	600	197	123	14

TABLE II

Mean amplitudes (A) for the XY₃Z silicon compounds

Molecule	$\sigma_R^{\frac{1}{2}}$ Si-Z	$\sigma_\gamma^{\frac{1}{2}}$ Si-Y	$(\sigma_a-\sigma_{aa})^{\frac{1}{2}}$	$(\sigma_\beta-\sigma_{\beta\beta})^{\frac{1}{2}}$	$\sigma_\gamma^{*\frac{1}{2}}$ Y-Y	$\sigma_R^{*\frac{1}{2}}$ Y-Z
SiD₃H ..	0·08851	0·07416	0·18680	0·24080	0·09827	0·17990
SiH₃F ..	0·04005	0·08804	0·22420	0·16650	0·12780	0·13480
SiH₃I ..	0·06071	0·08835	0·25230	0·19590	0·12720	0·14020
SiF₃H ..	0·08770	0·04005	0·12390	0·19360	0·05623	0·15020
SiF₃D ..	0·07350	0·03994	0·12060	0·17520	0·06007	0·13230
SiCl₃H ..	0·08800	0·05467	0·15170	0·19360	0·07836	0·15020
SiB₃rH ..	0·08800	0·05809	0·15700	0·20840	0·12470	0·15420
SiBr₃Cl ..	0·05445	0·05825	0·14590	0·15920	0·07943	0·11900
SiI₃Cl ..	0·05410	0·06066	6·17260	0·15890	0·08764	0·11800
SiCl₃Br ..	0·05794	0·05504	0·19410	0·13050	0·06752	0·10580
SiCl₃I ..	0·06080	0·05512	0·12510	0·10070	0·07766	0·10950

with $3a_1 + 3e$ modes of vibrations. The orthonormalised set of symmetry co-ordinates and the elements of the kinetic energy matrices employed here are the same as given by Venkateswarlu and Thanalakshmi. In calculating the mean amplitude quantities, angle deviations have been multiplied by appropriate equilibrium distance values in order to have the same dimension to all symmetry co-ordinates.

The elements of the mean-square amplitude matrix Σ are obtained by solving the secular equation $|\Sigma G^{-1} - \triangle E| = 0$, where G^{-1} is the inverse of the kinetic energy matrix and the values of $\triangle$ are given by the equation $\triangle = h/8\pi^2\nu$ coth $(h\nu/2kT)$, ν is the normal frequency, h is

$\sigma_R^{\frac{1}{2}}$ and $\sigma_r^{\frac{1}{2}}$ are the mean amplitudes of vibration for the bonded X-Z and X-Y atom pairs $\sigma_a^{\frac{1}{2}}$ and $\sigma_\beta^{\frac{1}{2}}$ represent the mean amplitude quantities due to the YXY and YXZ bending and $\sigma_{aa}^{\frac{1}{2}}$ and $\sigma_{\beta\beta}^{\frac{1}{2}}$ are the respective interaction terms. $\sigma_\gamma^{*\frac{1}{2}}$ and $\sigma_R^{*\frac{1}{2}}$ are the non-banded mean amplitudes. From the values presented in Table II it is evident that the mean amplitude values of Si-F, Si-Cl, Si-Br and Si-I increase as the mass of the substituted atom increases. Si-H and Si-D behave in a contrary way.

Physics Department,   K. VENKATESWARLU.
Kerala University,   (MISS) V. MALATHY DEVI.
C/o U. C. College,
Alwaye, *April 7, 1965.*

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FREE AMINO-ACIDS AND CAROTENES IN THE LEAVES OF *MORINGA OLEIFERA* LAM. SYN. *MORINGA PTERYGOSPERMA* GAERTIN.

Moringa oleifera Lam. is cultivated throughout the hotter parts of India and leaves, flowers and fruits are widely used as vegetables. Many medicinal properties are attributed to it in the Indian indigenous systems of medicine.[1] Reports have already been made about the amounts of vitamins C[2] and E[3] and the stability of vitamin C[4] in the leaves. The present communication describes the free amino-acids and carotenes in the leaves.

Free amino-acids.—Fresh leaves were homogenised with 80% ethanol (final concentration) and extracted repeatedly. The extracts were combined and concentrated to dryness under reduced pressure and dissolved in the minimum quantity of 80% ethanol. Varying amounts of this solution were subjected to two-way descending paper chromatography to get optimum concentration of each amino-acid for estimation. [Paper—Whatman No. 1 ; Solvents—I-Butanol-acetic acid-water (120 : 30 : 50 v/v), II-Phenol-water (80 : 20 w/v)]. Methionine was estimated after peroxide oxidation of the sample.[5] After resolution and drying the chromatograms were sprayed with 0·4% ninhydrin in acetone and dried in the air for 30 minutes. The chromatograms were then heated at 60° C. for 10 minutes and the position of each amino-acid was compared with that obtained for standard amino-acids under identical conditions. Confirmation was also obtained by co-chromatography of standard amino-acids along with test solutions. The coloured band of each identified amino-acid was cut and extracted with 75% ethanol containing 0·25 mg. per cent $CuSO_4.5H_2O$ and the absorption read at 540 mμ. The semi-quantitative estimation showed the following composition of free amino-acids in the leaves (Conc. in mg. per cent) :

Aspartic acid (24·5), glutamic acid (10·5), serine (7·5), glycine (5·5), threonine (14), α-alanine (13·5), valine (12·0), leucine and isoleucine (4·5), histidine (9·5), lysine (4·5), arginine (9·0), phenylalanine (4·0), tryptophan (3·5), cystine (5) and methionine (3·5).

Carotenes.—The ether extract of the leaves (100 g.) was prepared according to the method (b) of Goodwin.[6] The solvent was removed under reduced pressure and the residue dissolved in light petroleum. Chlorophyll was completely removed by passing the petroleum extract through a short column of methanol deactivated alumina using light petroleum as eluant. The eluate was concentrated under reduced pressure and the oil thus obtained was dissolved in ethanol and saponified.[7] The insaponifiable material taken in light petroleum was chromatographed on Magnesium oxide—Hyflo super cel (1 : 1) mixed column using light petroleum containing 10% (v/v) acetone as eluting solvent. The eluate was concentrated and rechromatographed on deactivated alumina (2% water) using light petroleum containing varying amounts (0–15% v/v) of ether as the developing and eluting solvent. Fractions were collected, evaporated under reduced pressure, dissolved in light petroleum and the absorption in the range of 400–500 mμ was studied. The concentration of α- and β-Carotenes were determined by measuring E_{max} and comparing it with known $E_{1cm}^{1\%}$ values at λ_{max} for pure pigments (Goodwin *loc. cit.*). It was found that 100 gm. of the fresh leaves contain 110 μg. of β-Carotene and 13 μg. of α-Carotene.

Department of Chemistry,   J. MOHAN DAS.
University of Kerala,
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A NOTE ON THE BIOGENESIS OF CHEMICAL COMPONENTS OF *ROCCELLA MONTAGNEI*

Roccella montagnei, one of the well-known Indian lichens, has been chemically investigated in an exhaustive manner by Seshadri and co-workers[1-3] and it is unique in biosynthesising a variety of chemical structures in its chemical components which range from the simple compounds like orcinol and erythritol, esters of erythritol with orsellinic acid (montagnetol) and lecanoric acid (erythrin), a derivative of succinic acid with $-CH_3$ and $-C_{12}H_{25}$ *n*-alkyl chain (roccellic acid) to complex ones like a steroid (ergosterol) and a higher terpenoid (β-carotene). Recently the amino-acid composition of this lichen has been reported[4] from our laboratory and it has now been observed that the lichen is rich especially in leucine. A comparative study of the chemical structures of these different components occurring together in significant amounts in this lichen appears to be very interesting in the light of a recent publication by Richards and Hendrickson.[5]

In a remarkable statistical survey of natural compounds these authors[5] have pointed out that the chemical structures of about 85% of these natural products could be correlated with 'acetate origin' in a unified manner and suggested a fitting generic name called 'acetogenins' (genesis from acetate) for these compounds. The conversion of acetate to the acetogenins such as fatty acids is well established and the formation of orsellinic acid (C_8 unit) from acetate as a major step in the production of other natural products (with aromatic rings) has also been recognised. Direct incorporation of acetate in steroid unit is generally accepted. In the case of terpenoids acetate and mevalonate take part, the major biological role of mevalonate being a precursor for the polyisoprenoid units. The complex sequence of interconversions

between acetate, leucine and mevalonate has also been established.[5]

In the understanding of the principles of biogenetic theory, the co-occurrence of closely related chemical structures in the single biological source is given some consideration. In recent years, biogenetic pathways (formerly based mechanistically on laboratory reactions and speculative ingenuity) have been proved by more rigorous experimental verifications and the mechanisms of elaboration of aromatic compounds, terpenoids, steroids, etc., are being more and more understood by such experiments affording direct evidence and considerations of neighbouring group participation in natural products chemistry.[6] However, the co-occurrence of secondary chemical components with different structures in the same biological species as in the case of *R. montagnei* deserves special consideration and a comparative study of the different structures occurring together in this lichen obviously affords a veritable example in support of a unified basis for the biosynthesis of natural products as reviewed by Richards and Hendrickson.[5] It could be expected that many other biological sources having a similar significance are also found in the literature.

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A NOTE ON MONSOON THEORIES

THE explanation given by Halley (1686) for the monsoon winds is probably the first theory and considered to be complete and satisfactory for a long time. The theory in brief, states that a large area surrounded by ocean is heated or cooled to a higher or lower temperature than the surrounding ocean during smmer and winter respectively. This causes a low pressure in summer and high pressure in winter over the land. Consequently cyclonic winds blow across the coast into the land in summer and

anticyclonic off-shore winds prevail in winter. The theory further explains, that summer monsoon, being converging and blowing from ocean to heated land, is associated with humid and rainy weather while the winter monsoon, being from land to ocean and diverging, is characterised by clear skies and dry weather.

Flohn (1958 a) raised the following objections, questioning the validity of Halley's differential heating theory. In the case of South America and certain parts of North America which are big continents surrounded by oceans, no monsoon winds are observed. The monsoon winds on the East coast of North Africa are parallel to the coast but not across it. On the other hand, monsoon wind changes are observed in oceanic regions. In view of these facts Flohn suggested that the migration of the pressure and wind belts across latitudes with seasons, is responsible for the monsoon winds in addition to the differential heating. The migration, according to him, exists even if the whole globe is covered with either oceanic or land surface. In the former case the displacement is small and the coriolis force between the equator and the displaced trough (doldrums) is so small that equatorial westerlies cannot form. On a land covered globe the displacement is large enough for the formation of equatorial westerlies. The existing earth's surface being partly covered by oceanic and partly by land surface, prominent wind changes are noticed in the continental sections.

It is needless to mention here in detail that the Asiatic monsoons are the best developed in the world. Flohn (1958 b) attributed the significant development to the heating of Tibetan Plateau from which the circulation derives its energy to start with. Koteswaram (1958) supported this view-point. Recently Rangarajan (1963) found no observational evidence to support the above hypothesis. On the other hand, a diffuse warm ridge has been found to extend east-west along the entire Asiatic continent between the 25th and 30th parallels at 500 mb. level. He stressed that the situation of the long warm belt cannot be linked solely with the Tibetan Plateau but with the entire Asiatic landmass itself. Thus we come back again to the original idea that the Asiatic monsoon is pronounced because the continent Asia is very large.

We have, then, the same old question unexplained ; namely, why monsoons are absent over South America and weak over North America which are big continents while they are better developed over Australia, a smaller continent.

The ultimate factors that would be responsible for the regional differences can only be geographic. A critical examination of the geography of the different monsoonal regions will however throw light on such factors. The differential heating theory of monsoons by Halley points out one such factor while Flohn's suggestion of the difference in the shift of the doldrums on land and oceanic globes is another. There are however a few more noteworthy factors which would be operative in producing monsoons.

A large oblong land area situated parallel to the latitudes would be more effective than one that is normal, in producing a pool of heated air. The winds on the globe are in general zonal. Hence the excess heated air that forms over land at any time will be transported parallel to latitudes. In the case of a narrow land area oriented normal to latitudes, the heated air is transported in a short time to the cool surroundings and the formation of a warm pool of air is obliterated, while it is not the case when the area has a longer stretch along the latitude. This principle may be partly responsible for the inhibition of monsoons over North and South America.

The intensity of heating is greatest in summer in the respective hemisphere near the tropic (cancer/capricorn) and further poleward. As such, the situation of the equatorward boundary of the land near the tropics augments the differential heating. This appears to be playing an important role in the summer monsoons of Asia and Australia.

The heated atmosphere over the land loses heat partly by meridional eddy transfer to higher latitudes. The diffusion of heat to higher latitudes by this process, in South Asia is obstructed by the great Himalayan ranges. Thus the broad elevated land across the continent localises the heating to the south. This type of prevention of heat exchange is present in the winter season also. The whole of Asia, north of Himalayas, experiences severe cold winter while to the south comparatively tropical climate is present. The Siberian anticyclone is the most severe on the globe partly because the Himalayan ranges keep the cool winds confined to the north and stop the addition of heat from the south. The cooling of the atmosphere on the north goes on reducing the temperature which results in the severe cold anticyclone. In this way the Himalayas have

a major contribution to the pronounced development of the Asiatic monsoons.

The above basic geographical factors must be responsible for the differences in the development of the monsoons in different continents. Finally it may be suggested that a problem can be formulated incorporating these basic aspects and solved by numerical methods to find out how far they are significant.

Dept. of Meteorology and   I. Subbaramayya.
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CAMBRIAN FAUNA OF KASHMIR WITH SPECIAL REFERENCE TO PALAEOGEOGRAPHY

CAMBRIAN ROCKS in the Hundwara region are well exposed along Talar and Mawar valleys on the North-West of the Kashmir valley. In the Talar valley, fossils are preserved in isolated pockets in grey and green sandy slates and bluish shales. The cleavage of the rocks is oblique to the bedding which makes the extraction difficult. The bulk of fauna consists of trilobites.

This region was surveyed previously by Wadia (1934) and the fauna obtained by him was described by Reed (1934) who found that all the species were new. However, the fauna was fragmentary and, except for one specimen of *Anomocare hundwarense* Reed, consisted either of cephalons or pygidia alone. The present authors have been successful in obtaining many complete specimens in a tolerable state of preservation. This necessitates the revision of the entire fauna on the basis of the complete specimens obtained now. There are also some new species and others similar to the species recorded elsewhere. The work in this direction is in progress.

During the present study it was noticed that within a limited thickness there are distinct faunal assemblages. Three such assemblages with characteristic species have been observed, namely, the *Ptychoparia-Solenopleura* assemblage, the *Anomocare* assemblage and the *Conocoryphe* assemblage. The last is undoubtedly the youngest and is associated with some atrematous brachiopods. The bulk of the fauna

belongs to middle Cambrian while the last assemblage may belong to the base of the upper Cambrian.

The fauna is undoubtedly endemic as remarked by Reed (1934), and is not related to any fauna in the neighbourhood. The species are new and even the genera are quite distinct from those of Spiti and Salt Range. *Redlichia* is characteristically absent here although it is present in the Salt Range, Persia, Yunnan and in Spiti. From early times, the students of Cambrian faunas have created three faunal provinces in lower and middle Cambrian which are supposed to have evolved separately from one another because of the presence of unbroken land barriers. These are the Pacific Province, Atlantic Province and Australo-Asian Province characterised by *Olenellus, Holmia-Callavia* and *Redlichia* respectively in lower Cambrian times. The fauna of Spiti bears a close relationship to the Pacific Province fauna and so in the earlier palaeogeographic maps Spiti area was shown to be connected with the Pacific Ocean in middle Cambrian times. It was presumed to be separated from Salt Range and Kashmir faunal provinces, the former being connected to the *Redlichia* sea. The connection of Kashmir to the other two seas could not be visualised as it contains a totally distinct faunal assemblage with affinities to the Atlantic Province with which by no stretch of imagination it can be connected. Thus the palaeogeography of Kashmir Cambrian has so far been an enigma.

In recent years it has been shown that there is no clear division of the three faunal provinces; a mixture of the *Holmia-Callavia* and *Olenellus* fauna, *viz.,* the *Atlantic* and Pacific fauna, has been recorded from the far Western Cordilleran region and southern and eastern border of North America (Lochman-Balk and Wilson, 1958) and in Greenland and Spitzbergen (Cowie, 1960), and a mixture of *Olenellus* and *Redlichia* fauna in Morocco and Spain (Cowie, 1960). Cambrian biostratigraphers in North America have postulated the view that the basic reason for the distinction of "Atlantic" and "Pacific" province assemblages is "the contiguous existence of three biofacies realms oriented concentrically with respect to the continent—Laurentia" (Lochman-Balk and Wilson, 1958). These three biofacies are the cratonic, extra-cratonic intermediate and extra-cratonic (euxinic) which are based on environmental and tectonic control. Cratonic facies replaces the term "Pacific" province and is indicative of shelf conditions, whereas the extracratonic

replaces the "Atlantic" province and denotes miogeosynclinal and eugeosynclinal conditions.

After a study of the fauna, the present authors are of the opinion that the Kashmir fauna is extracratonic (euxinic) for it contains in bulk such genera as *Conocoryphe, Anomocare, Solenopleura, Agnostus*, etc. The Spiti fauna is more or less of the extracratonic intermediate zone, as it contains such elements as *Zacanthoides* and *Oryctocephalus* which are known from the intermediate zone of North America and this explains the similarity of the fauna of Spiti and that region. In Salt Range only lower Cambrian seems to be represented and the fauna is of the cratonic type. Salt Range had been all along a shallow shelf on the margin of the former geosyncline. Towards the north the fauna of China, South Korea and Manchuria is also of cratonic nature. Indo-China however contains extracratonic elements and shows similarity to Kashmir fauna. The authors are therefore of the opinion that the central part of the Cambrian Sea in this region showing the deepest zones are those of Kashmir and Indo-China, whereas the margins of this sea are represented by the Salt Range in the south and by China and South Korea in the north. Spiti region is of intermediate nature. The lithological evidence also seems to support this fact. In the Salt Range the trilobites are entombed in sandstones and light shales, in Spiti they are found in quartzites, sandstones and limestones, whereas in Kashmir they are present in typical blue muddy shales which are elsewhere associated with graywackes (Wadia, 1934). From this it is inferred that in Cambrian times the same sea covered the entire Himalayan region and the variation in fauna that is met with in Spiti, Salt Range and Kashmir is due entirely to the change of the environmental factors in the three depth zones.

Post-Graduate Dept.   S. N. WAKHALOO.
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Jammu and Kashmir
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FRESHWATER CARPS AS SECOND INTERMEDIATE HOST OF AN OPISTHORCHIID FLUKE PARASITIC IN SILURID FISHES

A NUMBER of opisthorchiid species, so far described by Verma (1927), Thapar (1930), Mehra (1941), Dayal (1949) and Gupta (1953), are from such of the carnivorous freshwater fishes as *Rita rita, Bagarius yarrelli, Wallagonia attu, Macrones seenghala* and *Gugatia cenia*. The normal habitat of these flukes is gall bladder but the location, in a few cases, has been recorded as intestine. In Opisthorchiidæ, with a number of genera in reptiles, birds and mammals including man, the life-cycle studies conducted in such of the significant species as *Opisthorchis sinensis* (Cobbold, 1875), *O. felineus* (Riv., 1884) Blanch., 1895 and *O. viverrini* Poirrier, 1886 have shown that various freshwater fishes act as second intermediate hosts. In addition, the role of carnivorous mammals— domestic and wild—as reservoirs of human infection in the endemic areas has been proved during studies on epizootiology of liver cirrhosis. This aspect of human helminthology has not as yet attracted the attention of medical helminthologist in our country nor attempts have been made to ascertain the incidence of metacercarial stages of species, occurring in non-human host, in our fishes.

With a view to assess the prevalence of opisthorchiid metacercariæ of piscine, reptilian, avian and mammalian origin in the musculature of our freshwater fish fauna, a survey among the local carps, *viz., Cirrhina mrigala, Labeo rohita* and *Catla catla*, was undertaken. *C. mrigala* and *L. rohita* proved positive for this infection. Of the one hundred and twenty-three specimens, eighty-two of the former and forty-one of latter, available for examination,

fourteen metacercariæ were found lying just below the skin between the pelvic and caudal fins of two specimens in each of these species. The cysts after collection were examined and are herein described with the young flukes studied after extraction. The infection in the present case has been identified as due to the metacercaria of *Opisthorchis pedicellata* Verma, 1927 and/or *O. pedicellata minuta* Mehra, 1941 described from *Rita rita, Macrones seenghala* and *Wallago attu.*

The small cyst has thin wall, is white and of elliptical shape exhibiting a characteristic dark streak near its middle (Fig. 1). It measures
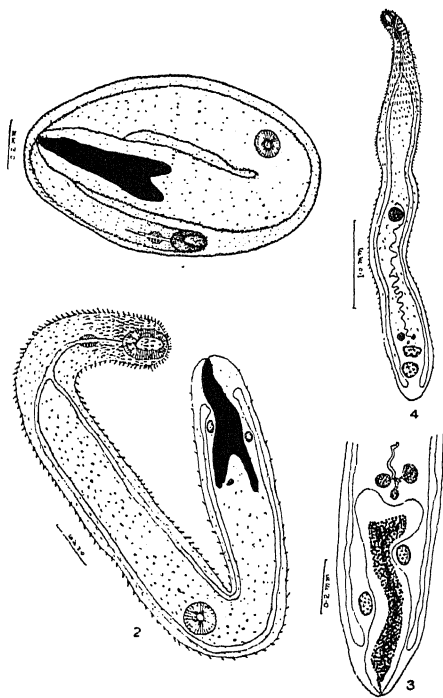
FIGS. 1–4. All Camera Lucida drawings. Fig. 1. A cyst. Fig. 2. The juvenile form after extraction from a cyst. Fig. 3. Stained preparation, after mercury chloride fixation, of the posterior part to show excretory bladder and gonads. Fig. 4. Stained permanent mount of a young fluke.

$1 \cdot 0 - 1 \cdot 5 \times 0 \cdot 6 - 0 \cdot 82$ mm. in size. The young fluke, with spine on its cuticle, lies folded on itself and performs slight movements clearly showing the prominent excretory bladder, with its two anterior limbs, in the posterior half of the cyst. The ventral sucker and the oral sucker, followed by pharynx and part of the œsophagus, are also visible. The juvenile form (Fig. 2) excysts on slight pressure or when the cyst is left in normal saline for a couple of

hours. It is elongated in shape, capable of active movement and spined throughout. The characteristically sigmoid - excretory bladder shows the distinct *y*-shaped form with its anterior cornua. It passes between the two obliquely placed testes extending anteriorly between the anterior testis and ovary (Fig. 3).

In the permanent stained preparations, the young fluke measures $2 \cdot 76 - 6 \cdot 8$ mm. in length and $0 \cdot 27 - 0 \cdot 63$ mm. in maximum breadth in the regions of ventral sucker and ovarian zone. The subterminal oral sucker, $0 \cdot 18 - 0 \cdot 22$ mm. in size, leads into a prepharynx of $0 \cdot 04 - 0 \cdot 1$ mm. length and followed by the pharynx, of $0 \cdot 08 - 0 \cdot 1 \times 0 \cdot 048 - 0 \cdot 08$ mm. size, which leads into œsophagus $0 \cdot 32 - 0 \cdot 36$ mm. long. The two intestinal cæca extend posteriorly to a distance of $0 \cdot 04 - 0 \cdot 3$ mm. in front of the posterior extremity. The ventral sucker, $0 \cdot 16 - 0 \cdot 24$ mm. in size, is situated near the middle of the body at $1 \cdot 5 - 3 \cdot 5$ mm. distance from the anterior extremity. The gonads and their position, the rudiments of the uterus, the terminal genital ducts and the genital pore are all distinctly visible. The intercæcal testes lie slightly oblique in position—the anterior testis being $0 \cdot 12 - 0 \cdot 24 \times 0 \cdot 1 - 0 \cdot 192$ mm. in size and the posterior of $0 \cdot 12 - 0 \cdot 26 \times 0 \cdot 12 - 0 \cdot 8$ mm. in size and situated at a distance of $0 \cdot 228 - 0 \cdot 36$ mm. from the posterior extremity. Pretesticular ovary, $0 \cdot 048 - 0 \cdot 108 \times 0 \cdot 048 - 0 \cdot 1$ mm. in size, lies laterally. The uterine coils extend along with the middle of the body between the anterior testis and ventral sucker with the rudiments of external genitalia developing just in the anterior region of ventral sucker (Fig. 4). The metacercarial stage on grounds of topography of its organs, the sucker ratio, the character and extent of excretory bladder and spiny character of its cuticle belongs to the species described as *Opisthorchis pedicellata* and/or *O. pedicellata minuta* from siluroids. The present finding is thus a first report of our carps acting as its second intermediate host.

Department of Parasitology,   P. RAI.
U.P. College of Veterinary   B. P. PANDE.
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SOME OBSERVATIONS ON THE EFFECT OF GAMMA RADIATIONS ON THE EGGS OF *HOEMONCHUS CONTORTUS* (RUDOLPHI, 1803)

THE effect of gamma rays on the eggs of helminth parasites has not been worked out so far in India. During the summer of 1963 the author got an opportunity of working on this aspect at the Biology Division of the Atomic Energy Establishment, Bombay.

The adult parasites of *Hœmonchus contortus* (Rudolphi, 1803) were collected in the evening from the abossum of sheep freshly slaughtered at the Bandra abattoir, Bombay. The parasites were washed thoroughly in distilled water and kept in Locke-Lewis solution at a temperature 15–20° C. The mature females were picked out next morning, their uteri ruptured and eggs taken out. Five hundred eggs were kept in each Durham tube in 7–10 minims of distilled water and cotton-plugged. Four such tubes were kept in each large vial which was corked. These vials were carried from the laboratory to a distance of about 20 miles to the Canada-India Reactor at the Atomic Energy Establishment, Trombay, for irradiations. They were then brought back to the laboratory and the eggs were transferred to solid watch glasses for hatching.

All exposures were carried out in a radiation chamber. Gamma rays were obtained from two-plate source of $Co^{(60)}$ and the dose rate was $1\cdot3 \times 10^5$ r. per hour. The eggs were exposed to different doses ranging from 5,000 r. to 50,000 r. For each dose four vials were kept in the radiation chamber at one time. This experiment was performed twice. Hatching of eggs was observed after 40 hours to allow maximum hatching. Eggs for control experiments were also taken to the irradiation centre under similar conditions so that all other factors remained same in control and experimental tubes.

It was observed that survival of eggs was inversely proportional to the exposure dose. As the dose was increased mortality also increased, and with a dose of 20,000 r. only 47·7% eggs remained viable. So LD 50 has been calculated on the basis of 16,000 eggs at each dose. Taking control eggs as cent per cent viable, the mortality of eggs exposed to different doses has been plotted in the graph. The experiments showed that eggs did not become completely sterile even after irradiation with a dose of 50,000 r.
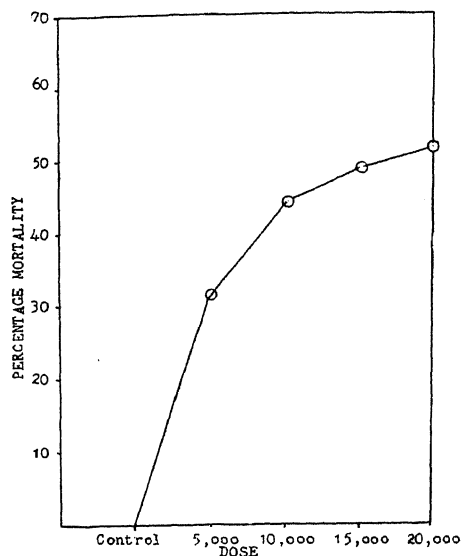
FIG. 1. Percentage mortality of the eggs of *Hœmonchus contortus* at control and after irradiation with different doses of gamma rays.

Zoology Department,   PREMVATI.
University of Lucknow,
February 26, 1965.

SEDIMENTATION OF SERUM PROTEINS BY SLOW FREEZING

PRESERVATION of immune or other serum at low temperatures is a universal practice. During the course of my work on such material it has been observed repeatedly that freezing of blood serum in Pyrex test-tubes (12×100 to 16×125 mm.) at − 5° C. or so in 1 to 3 hours causes the formation and separation of some quantity of clear 'ice' at the top. Some observations on this phenomenon have shown that the formation of ice is facilitated by the addition of a small quantity of physiological saline solution but is not dependent upon it. Further, instead of being limited to the top, it can be made to progress downward with repeated

freezing and thawing, so that eventually the proteins settle down in the form of a flocculum in the distal one-fourth or less of the total column. The junction is not very distinct, but the two layers can be maintained as such if the tubes are left undisturbed at room temperature or in refrigerator without freezing. The contents can be readily mixed by shaking, and the serum so reconstituted stays unchanged but responds like fresh serum if again allowed to freeze slowly as indicated above.

That the clear material at the top is completely devoid of proteins (and of antibodies in the case of immune sera), and that these are concentrated in the flocculum below, has been verified by (a) electrophoresis, (b) colour reactions, and (c) serological tests, such as the agglutinationlysis test for leptospirosis, the capillary agglutination tests for Q fever and for anaplasmosis, and the standard tube agglutination test for brucellosis. The antibody content of the protein flocculum is found to be higher than that of the original serum not subjected to this process of slow freezing and of the serum so treated but reconstituted by shaking. The antibody titres of the protein column, in general, correspond with the degree of sedimentation of the proteins.

Sedimentation of proteins in the form of a flocculum is readily observed in cattle serum owing to its colour, but it occurs equally well with serum of buffaloes, sheep, goats, horses, and pigs. It does not occur if the serum is frozen more rapidly at $-10°$ C. or below. The critical temperature for separation to occur effectively in the test-tubes used would appear to be around $-5°$ C., a temperature commonly obtained in the freezing chamber of the ordinary refrigerator. Bacterial contamination seems to interfere with freezing and also with proper sedimentation.

The process is simple, inexpensive, and independent of the use of any chemicals. The repeated freezing and thawing involved does not appear to damage the proteins or, at any rate, lower the antibody titre. The method can be used with advantage in diverse diagnostic, therapeutic, and other biological techniques. Indications are that, with suitable modifications, perhaps it can also be developed for separation of the different protein fractions.

Livestock Research Station,   R. N. MOHAN.
Mathura, U.P. (India),
January 23, 1965.

POLLEN MORPHOLOGY OF INDIAN PODOSTEMACEAE

THE Podostemaceæ is an aquatic family, and its systematic and phylogenetic position have been variously interpreted. Bentham and Hooker placed this family in the order Multiovulatæ aquaticæ under the Monochlamydeæ, while other taxonomists placed it under Rosales (Engler and Prantl), Caryophyllales (Bessey), Ranales (Hallier), or Podostemales (Hutchinson ; see Lawrence[1]).

Pollen morphology of the plants belonging to the Podostemaceæ is little known,[2] possibly due to the difficulties in procuring the polliniferous material. Mention of pollen morphology is also available in embryological literature.[3-6]

The present study includes the following species : *Dicræa stilosa* Benth. Hook. f., *Farmaria metzeroides* Willis, *Podostemon subulatus* Gardn., and *Zeylanidium lichenoides* Engl. Pollen material preserved in FAA has been obtained from Prof. M. A. Razi, Botany Department, Central College, Bangalore (India). Pollen preparations have been made by the acetolysis method.

In all the species studied, pollen grains are held in dyads (Figs. 1-2); single grains are
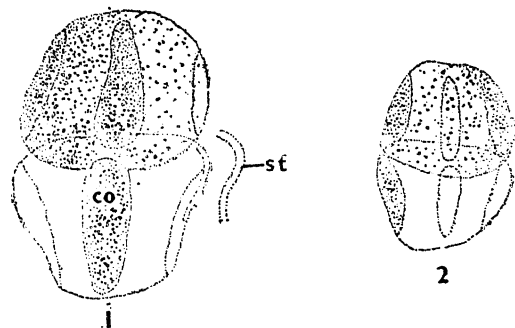
FIGS. 1-2. Fig. 1. Pollen dyads of *Dicræa stilosa*. Fig. 2. *Zeylanidium lichenoides. co*, colpus ; *st*, strata.

3-zonocolpate (colpi indistinctly demarcated ; appearing as inaperturate). Exine is very thin (thickness below $1\,\mu$), surface pattern granulose in the different species. The average size measurements of the dyads (longest diameter × shortest diameter) in the different species are as follows : *Dicræa stilosa* $(39 \times 21\,\mu)$; *Farmaria metzeroides* $(43 \times 29\,\mu)$; *Podostemon subulatus* $(39 \times 25\,\mu)$; *Zeylanidium lichenoides* $(36 \times 21\,\mu)$.

Pollen being held in dyads, the Podostemaceæ is unique among the members of the Monochlamydeæ. Erdtman[2] suggested that pollen grains are 3-colporoidate in Weddllinoideæ, 1-porate in Tristichoideæ (sensu Engler), and

3-colpate as well as inaperturate in Podostemoideæ.

The phylogenetic position of the Podostemaceæ has been variously interpreted.[1] The family has been considered to be close to the Saxifragaceæ (Warming; Engler); to be much reduced apetalous types of Saxifragales; or to have affinities with Rosales. The indistinct nature of the colpus in the grains of members of Podostemaceæ might be considered to indicate reduction of colpi from similar forms in the Saxifragales. The Hydrostachyaceæ, allied with Podostemaceæ in the order Podostemales by Hutchinson, have sporomorphs united in tetrads (at maturity) and also inaperturate, as in some of the Podostemaceæ.

I am grateful to Prof. K. N. Kaul for encouragement, and to Dr. M. A. Razi for supplying the pollen material.

National Botanic Gardens,   P. K. K. NAIR.
Lucknow, *December* 24, 1964.

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A PRELIMINARY STUDY OF WHITE MUSCARDINE FUNGUS ON CABBAGE SEMILOOPER FROM MYSORE

Beauveria bassiana (Bals.) Vuill., commonly referred to as white muscardine fungus-causing disease of silkworm, *Bombyx mori* Linn., is also a well-known entomogenous fungus of some importance in the control of many noxious insects. Preliminary laboratory studies were undertaken with *B. bassiana* attacking silkworm with a view to find out possibilities of utilising the same against the cabbage semilooper, *Plusia* sp. This is a common leaf-eating semilooper pest on a variety of economic crops like Cabbage, Tomato, Cotton Beans, Lettuce and Alfalfa.

The genus *Beauveria* has been established by Vuillemin in honour of Beauverie who studied the characteristics of the white muscardine fungus, *Botrytis bassiana* Bals., and the related species *B. effusa* Beauv., found on silkworm. He further recommended for the erection of a new genus *Beauveria* to include both these species.[6] Das Gupta[2] was one of the earliest workers to report *B. bassiana* under the name *Botrytis bassiana* from India as the causal

organism of the muscardine disease of silkworm. MacLeod,[4] while making a critical examination of the genus *Beauveria*, is of the opinion that there are only two valid species, *viz.*, *B. bassiana* and *B. tenella* (Delacr.) Siem. Several corkers have reported 'fungus disease' other than *B. bassiana* on *Plusia* spp., occurring on various crops.[1,3,5] From review of literature there appears to be no record of any entomogenous fungus on *Plusia* sp. from India.

In the course of the present studies, fungus-affected silkworms which were collected (Fig. 1)
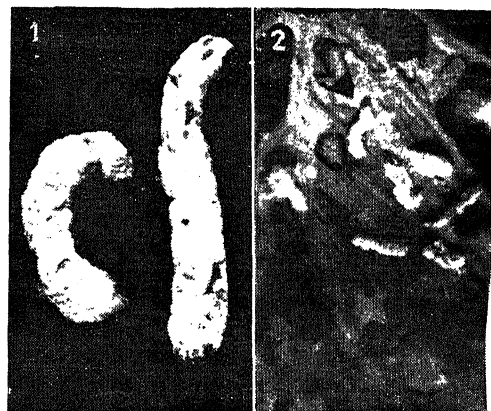
FIGS. 1-2. Fig. 1. Silkworm larvæ infected with *Beauveria bassiana* (Bals.) Vuill., with typical white muscardine growth of the fungus. Fig. 2. *Plusia* sp. caterpillar on damaged cabbage leaves parasitised by *B. bassiana*.

on examination revealed the presence of *Beauveria bassiana*. Dilute chlorine water (1 : 5) was used for surface sterilization to isolate the fungus. After repeated wash in sterile distilled water, the caterpillars were directly placed on the poured plates of Sabouraud maltose media. Few isolations were also made from the internal mycelium of the silkworm aseptically by squeezing with spatula to release the contents of the insects (including internal mycelium) to the petri dish containing a drop of sterilised distilled water. They were further streaked on the poured plates of the same media. Successful growth of the fungus with the characteristic cylindrical-shaped coremia was observed. The conidia observed on artificial culture measured $1 \cdot 5-2 \cdot 25 \mu$. Pathogenecity of the fungus on silkworm was also established in the laboratory.

Caterpillars of *Plusia* sp. were collected and bred into moths in the laboratory. Further generations were reared in the laboratory on cabbage leaves. Rearing was done in 6″ diameter petri dishes. Inoculation was done by allowing

10 (second instar) larvæ to crawl on the culture for 2-3 minutes. Later these larvæ were reared in a separate petri dish. It was significant that 9 out of 10 larvæ developed typical white muscardine growth of the fungus on the third day (Fig. 2). The other caterpillar was active and moulted into the third instar; however, it was observed to be infected and was mummified on the fourth day followed by the growth of the fungus.

Division of Plant   N. V. Ramaraje Urs.
    Pathology,   H. C. Govindu.
Agric. Res. Inst.,   K. S. Shivashankara Sastry.
Hebbal, Bangalore-24, *February* 24, 1965.

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* Original not seen.

VASCULAR ANATOMY OF HUMIRIACEAE

There is no published account on the floral anatomy of the family Humiriaceæ, which comprises three genera, *viz.*, *Humiria*, *Vantanea* and *Saccoglottis*.[5] Bentham and Hooker[1] placed the family in the Order Geraniales while Hutchinson[3] kept it under Malpighiales. Engler and Prantl[2] treated it as a subfamily of the Linaceæ. The present paper deals with the floral anatomy of *Saccoglottis uchi* Huber.

The flower is pedicellate, bisexual, regular, 5-merous and hypogynous. The sepals are imbricate (Fig. 3) and show basal connation. The free petals show contorted æstivation (Figs. 8, 9); in some flowers imbricate condition has also been observed (Fig. 10). The androecium consists of 20 stamens which are basally connate (Figs. 7, 8). However, in some flowers up to 22 stamens have been observed. The 5-carpellary, syncarpous gynœcium is 5-locular at the base (Fig. 9) and unilocular at the top (Fig. 10). There is one pendulous ovule in each loculus (Fig. 9). The common style is hollow and splits into five stigmatic lobes. The star-shaped stylar canal is lined by transmitting tissue. A massive, 10-lobed,

vascularized disc is present and is adnate to the base of the ovary (Figs. 7, 8).

The pedicel shows a ring of discrete vascular bundles (Fig. 1). The traces for the calyx and
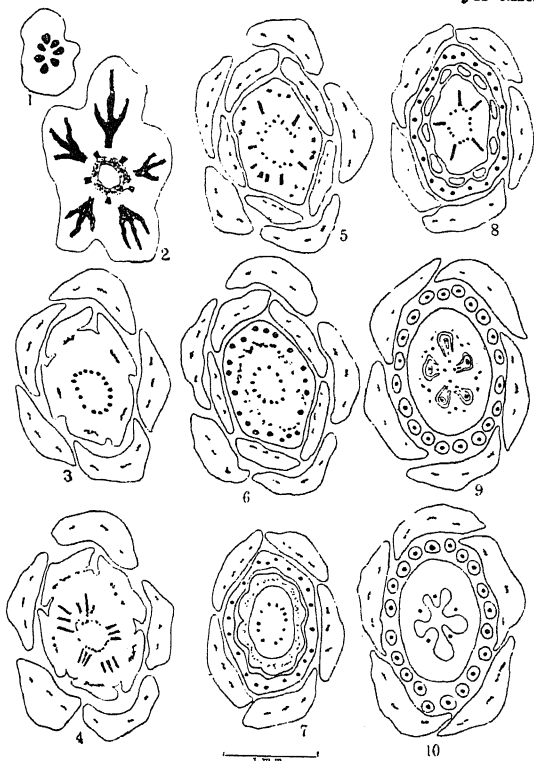
FIGS. 1-10. *Saccoglottis uchi*. Transverse sections of flower showing the origin and distribution of the vascular traces to the different floral parts.

corolla arise in two alternating whorls (Figs. 2, 3). The sepals are 3-traced, and the laterals arise conjointly with the mid-ribs (Fig. 2). The petals are single-traced (Figs. 2, 3). The origin of the staminal traces is noteworthy. They arise in two closely alternating whorls (Figs. 4, 5). The traces for the outer, antesepalous whorl of stamens arise in five groups of three each, a median and two laterals (Figs. 4, 5). The latter sometimes undergo splitting (Fig. 5) and the branches so formed supply the additional stamens noticed in some flowers. These are followed by the traces for the five antepetalous stamens (Fig. 5). All these traces diverge outwards and enter the base of the staminal tube (Fig. 7). In some of the flowers the staminal tube showed more than 20 bundles, though only 20 stamens were present. These additional bundles represent the persisting vascular supply of the suppressed stamens. The staminal traces, as they emerge

out. give off a number of branches which run through the nectariferous disc and fade away in the free lobes (Figs. 6-8). After the demarcation of the staminal traces, the dorsal carpellary traces and the common median laterals are organized along the sepal and petal radii respectively (Figs. 8, 9). While the former fade away early, the latter, after giving off branches into the ovary wall (Fig. 9), extend into the style and finally fade away in the stigmatic lobes. The remaining part of the main stele is used up in the formation of the ventral bundles which lie opposite to the loculi (Fig. 9). After giving off the ovular traces the ventral bundles extend upwards for a short distance and fade away at the level where the ovary becomes unilocular (Figs. 9, 10). The placentation in the light of Puri's concept (1952) is axile.

We thank Prof. M. R. Suxena for his kind interest and encouragement. We are deeply indebted to Dr. Bernard Verdcourt for the material.

Department of Botany.   D. RAO.
Osmania University,   L. L. NARAYANA.
Hyderabad-7 (A.P.), *February 8, 1965.*

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BASIC CHROMOSOME NUMBER IN ERAGROSTIS

DURING the course of a monographic study of Indian species of the genus *Eragrostis* P. Beauv., the writer came across an interesting situation in *E. diarrhena* (Schult.) Steud. In this species gametic number is 10 (Fig. 1) and in about 54% pollen mother cell varying degree of secondary association was noticed. Of particular interest are 18% cells in which the bivalents were secondarily associated in five discrete and regular groups, each group was composed of two bivalents (Fig. 2). If examined casually, these groups can be conveniently scored as regular quadrivalents, or, at places, as recently disjoined quadrivalents. Subsequent course of meiosis and fertility are perfectly normal. This finding is interesting in as much as it throws some light on the basic number of the genus.

To date about 55 species of *Eragrostis* have been studied cytologically and 10 has been regarded as basic number because it is the lowest

gametic number recorded in the genus.[1] On this basis, the various numbers can be arranged in a complete series of polyploids ranging from
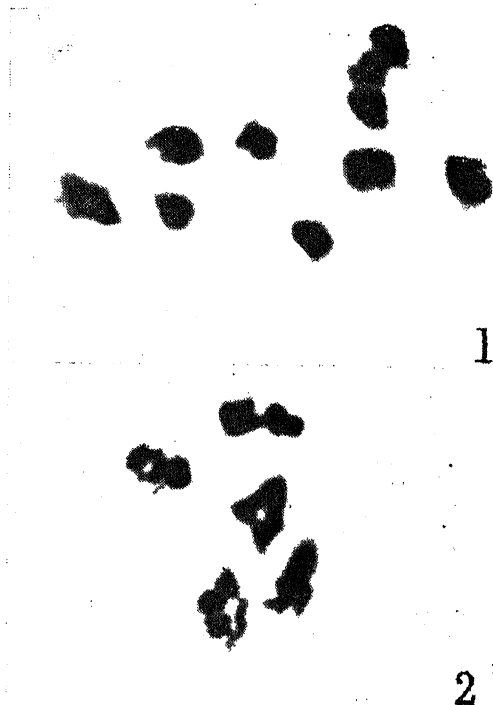
FIGS. 1-2. *Eragrostis diarrhena*. Fig. 1. $n = 10$. Fig. 2. Ten bivalents secondarily associated in 5 groups of 2 bivalents each, × 2,900.

$2x$ to $10x$. However, out of these, the species with $2n = 30, 50, 70$ and 90 are very interesting. The meiotic behaviour and the type of breeding system in such odd ploids has not been studied so far, but should prove to be rewarding. For instance, interpretations about the basic number will differ if the species with $2n = 30$ are sexual with 15 bivalents or triploid apomicts. In absence of such data, the secondary association seen in *E. diarrhena* gives a pointer towards the possibility of the basic number being 5 (Fig. 2) and not 10. Perhaps this may be true of such other genera of Eragrosteæ which also have $n = 10$. In this connection it is of interest to note that there is already direct evidence for 5 being as one of the basic numbers of Maydeæ, Andropogoneæ, Phalarideæ and Festuceæ.[1]

The writer is thankful to Prof. K. N. Kaul for facilities and to Dr. T. N. Khoshoo for help.

National Botanic   (MISS) KUM KUM ROY.
Gardens,
Lucknow, *January 18, 1965.*

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REVIEWS AND NOTICES OF BOOKS

The Red-Blood Cell—A Comprehensive Treatise. Edited by Charles Bishop and Douglas M. Surgenor. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. xiv + 566. Price $ 17.00.

This book brings together much knowledge regarding many aspects of the red-blood cell. It is the co-operative work of several persons who are experts in one phase or other of red cell function and who have done noteworthy research in their respective areas. Thus the book is a survey of the whole field intended for both the student and the practitioner giving an overall understanding of the subject. The field covered by this volume will be sufficiently indicated by the following list of fifteen chapters, their titles and respective authors : (1) Historical Introduction, by Max M. Strumia ; (2) Composition of Normal Human Red Cells, by Robert B. Pennell ; (3) Ion and Water Permeability of the Red-Blood Cell, by Hermann Passow ; (4) Overall Red Cell Metabolism, by Charles Bishop ; (5) The Pentose Phosphate Metabolism in Red Cells, by Zacharaias Dische ; (6) Glucose-6-Phosphate Dehydrogenase : Its Properties and Role in Mature Erythrocytes, by Paul A. Marks ; (7) Chemical Composition and Metabolism of Lipids in Red Cells of Various Animal Species, by L. L. M. Van Deenen and J. De Gier ; (8) Hemoglobin Metabolism within the Red Cell, by David W. Allen ; (9) Transport of Oxygen and Carbon Dioxide, by Douglas M. Surgenor ; (10) Blood-Group Substances : Their Nature and Genetics, by Winifred M. Watkins ; (11) Metabolic Processes Involved in the Formation and Reduction of Methemoglobin in Human Erythrocytes; (12) Life-Span of the Red Cell, by Nathaniel I. Berlin ; (13) Use of the Erythrocyte in Functional Evaluation of Vitamin Adequacy, by Myron Brin ; (14) Approaches to Red Cell Preservation in the Liquid State, by John G. Gibson II and (15) Red Cell Storage in the Frozen State, by James L. Tullis. C. V. R.

Photoelectric Effects in Semiconductors. By S. M. Ryvkin. (Consultants Bureau, New York), 1964. Pp. xv + 402. Price $ 22.50.

The aim of this book is to present contemporary understanding of the generation, motion and recombination of non-equilibrium carriers in semiconductors. Three introductory chapters give a phenomenological description of photo-conductivity, formulate preliminary definitions of some quantities and concepts, and describe the principles of various methods of studying photoconductivity. The processes of carrier generation are concisely analysed in Chapter IV. There follow thorough expositions of recombination processes (Chapters V–XI), and of the motion of non-equilibrium carriers (Chapters XII–XV).

The work serves a dual purpose : it provides stimulation for the scientist active in the field, and gives a firm foundation for the researcher undertaking the study of the working substance in this field. C. V. R.

Italian Physical Society—Proceedings of the International School of Physics "Enrico Fermi", Varenna, Italy. (Published by the Academic Press, Inc., 111, Fifth Avenue, New York, U.S.A.)

Course 24 : Space Exploration and the Solar System. Edited by B. Rossi, 1964. Pp. 311. Price $ 13.00.

The course ran from June 4 to 16, 1962, and its Director was B. Rossi. It was attended by sixty-one persons. The subject-matter of the course was covered in a series of nine lectures and the following were the speakers and the respective topics dealt with by them : R. Lust—Introduction to plasma physics ; S. Hayakawa and H. Obayashi—Canonical formalism of the motion of a charged particle in a magnetic field ; G. J. F. MacDonald—The structure and strength of the inner planets ; G. Righini—Survey on photospheric and chromospheric phenomena ; R. Lust—Solar corona and interplanetary medium ; T. Gold—Fields and particles in interplanetary space ; W. C. Lin and J. A. Van Allen—Observation of solar cosmic rays from October 13, 1959 to February 17, 1961 with Explorer VII ; R. Jastrow—Planetary Atmospheres ; S. Hayakawa—High-energy radiations from the planets and the moon.

Course 25 : Advanced Plasma Theory. Edited by M. N. Rosenbluth, 1964. Pp. 266. Price $ 9.75.

The course ran from July 9 to 21, 1962, and its Director was M. N. Rosenbluth. It was attended by 76 persons. The subject-matter of the course was dealt with in two sections. The first section comprised lectures and the

following were the speakers : W. B. Thompson—Kinetic theory of plasma ; Russel Kulsrud—General stability theory in plasma physics ; G. Ecker—Gas discharge theory ; M. N. Rosenbluth—Topics in microinstabilities ; H. P. Furth—Instabilities due to finite resistivity or finite current-carrier mass ; P. A. Sturrock—Nonlinear theory of electrostatic waves in plasmas ; C. Mercier—Equilibre et stabilite des systemes toroidaux en magnetohydrodynamique au voisinage d'un axe magnetique ; B. Bertotti—Boundary layer problems in plasma physics.

The second section comprised seminars and the following were the speakers : R. M. Kulsrud—Introduction for papers on adiabatic invariance ; R. M. Kulsrud—Adiabatic invariant of the harmonic oscillator ; M. Kruskal—The gyration of a charged particle.   C. V. R.

Advances in Hydro Science, Volume I. Edited by Ven Te Chow. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. 442. Price $ 15.00.

This new serial publication will be the source work for the latest data emerging from the study of water. It will cover the physical, chemical, biological, biochemical, radioactive and hydrodynamical aspects of water ; the man-made instruments, machines and structures employed in connection with water ; the use, re-use and control of water resources ; and the many specialized problems occurring within these broader classifications.

The present volume contains five articles as listed below : 1. Sonar, by Bradford A. Becken ; 2. Hydroelasticity, by S. R. Heller, Jr. ; 3. Statistical Hydrodynamics in Porous Media, by Adrian E. Scheidegger ; 4. New Contributions to Hydroballistics, by F. S. Burt ; and 5. Hydraulics of Wells, by Mahdi S. Hantush.
C. V. R.

Advances in Protein Chemistry, Volume XIX. Edited by C. B. Anfinsen, M. L. Anson, J. T. Edsall and F. M. Richards. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. viii + 408. Price $ 14.50.

The present volume of this well-known series contains four long articles. The first article is on "The Hemoglobins", by G. Braunitzer, K. Hilse, V. Rudloff and N. Hilschmann. This discusses in great detail the results of the X-ray analysis of hemoglobin and exhibits in the form of charts the amino-acid sequences with corresponding peptide chains in normal human hemoglobin. The second article is on "Hemoglobin

and Myoglobin", by Alessandro Rossi Fanelli, Eraldo Antonini and Antonio Caputo. The third article is on "Linked Functions and Reciprocal Effects in Hemoglobin : A Second Look, by Jeffries Wyman, Jr., and the fourth and concluding article is on "Thermodynamic Analysis of Multicomponent Solutions", by Edward F. Casassa and Henryk Eisenberg.   C. V. R.

An Introduction to Thermodynamics. By D. C. Spanner. [Academic Press, Inc. (London), Ltd., Berkeley Square House, Berkeley Square, London W. 1], 1964. Pp. xii + 278. Price 47 *sh.* 6 *d.*

This book is intended to introduce the subject of Thermodynamics to students of science in general and of biology in particular. The subject is traversed in a systematic fashion and with a special purpose in view, namely, to enable the foundations of such an abstract subject to be grasped and utilized by the students for the better understanding of their own special fields of scientific activity.

To indicate how the student is led on from the more elementary to the deeper aspects of thermodynamics, the titles of the fifteen chapters into which the book is divided are listed below : 1. The Nature of Thermodynamics ; 2. The First Law of Thermodynamics ; 3. Some Mathematical Topics ; 4. Reversibility and Irreversibility ; 5. Perfect Gases and Some Other Things ; 6. The Second Law of Thermodynamics ; 7. Entropy and Free Energy ; 8. Equilibrium and the Direction of Spontaneous Change ; 9. The Statistical Interpretation of Equilibrium and Entropy ; 10. Chemical Reactions and Membrane Equilibria ; 11. Chemical and Transport Processes in Dilute Solutions ; 12. Dilute Solutions of Electrolytes ; 13. The Thermodynamics of Water Relations ; 14. Photosynthesis, Thermodynamic Efficiency and ATP ; and 15. The Thermodynamics of Irreversible Processes.

The book is warmly recommended.
C. V. R.

Advanced Methods of Crystallography. Edited by G. N. Ramachandran. (Academic Press, New York and London), 1964. Pp. 273. Price 65 *sh.*

A Winter School on Advanced Methods of Crystallography was organized at Madras immediately following the International Symposium on Protein Structure and Crystallography during January 1963. Some of the scientists who attended the symposium were requested to deliver a course of three lectures each. The

present volume contains a report of the lectures so delivered, which have been amplified and written up for publication by the lecturers.

Nine lectures appear in this volume. As is naturally to be expected, three of them are by Indian authors. C. V. R.

Chemical Transport Reactions. By Herald Schafer. (Academic Press, New York and London), 1964. Pp. 161. Price $ 6.80.

This is a translation of a German edition of the book published a few years ago. It has been revised so as to take into account all significant investigations in the field made more recently. Chemical transport reactions cause the migration of solids (or liquids) *via* the gas phase by means of heterogeneous equilibria. They offer a multitude of applications in preparative chemical work. The predictability of the processes of heterogeneous reversible reactions facilitates their use in purification procedures, crystal growing, and mineralization systems. This monograph presents an extensive survey of the literature.

The six chapter headings in the book give an idea of the scope of the book, *viz.*, 1. Introduction and Historical Review ; 2. Experimental and Theoretical Principles ; 3. The Transport of Solid Substances and Its Special Applications ; 4. Information on the Reaction Process in the Gas Phase ; 5. Chemical Transport Processes as an Aid in Preparative Chemistry. Combination of Transport Reactions with Other Processes ; and 6. The Use of Transport Experiments in the Determination of Thermodynamic Values.

C. V. R.

Polycyclic Hydrocarbons, Volumes I and II. By E. Clar. (Academic Press, New York, and Springer-Verlag, Berlin), 1964. Volume I: Pp. xxvii + 487. Volume II : Pp. lvii + 487.

To the present reviewer these two volumes of *Polycyclic Hydrocarbons* are particularly welcome, because he has made frequent use of Clar's 1952 book on *Aromatische Kohlenwasserstoffe Polycyclische Systeme*. In an age of multi-author books, it is a refreshing change to read a book of nearly 900 pages written by a single author, who incidentally is supremely qualified to write it. The great majority of polycyclic hydrocarbons were prepared by him and the main method for the reduction of polycyclic quinones to hydrocarbons was developed by him. One exception is an interesting chapter on "Carcinogenesis" written by Miss Schoental. Curiously enough, the new English edition has

the same deficiency which was characteristic of the German book : the absence of a subject index. It is true that the very systematic treatment of the hydrocarbons makes the hydrocarbons themselves not too difficult to locate, but nonetheless a subject index would have fulfilled the useful purpose of listing the numerous related topics which are treated in the book.

Part I consists of 19 chapters and about 200 pages and covers nomenclature, qualitative theoretical aspects such as the aromatic sextet and its significance concerning the properties of aromatic systems, spectroscopic, magnetic, and electrical properties, and general methods for the preparation of aromatic hydrocarbons. The remainder of the two volumes consists of a systematic treatment of all the known polycyclic hydrocarbons extending from benzene to hydrocarbons consisting of 5- and 6-membered rings with formally fixed double bonds. The author states explicitly that the book is mainly concerned with the presentation of experimental material and empirical rules ; M.O. and V.B. methods and other theoretical aspects are dealt with very briefly and in qualitative terms. Thus the reader must look elsewhere for adequate coverage of such areas as the semiconductor properties of polycyclic hydrocarbons. The chapter on the possibility of bond fixation by substitution might well have been omitted if space could not be found for more modern and satisfying explanations of the experimental facts. More space might have been devoted to methods of preparation, for instance reduction by aluminium alkoxides, the procedure of Kelly and Shannon, and Rancy nickel desulphurisation. Among the reagents for dehydrogenation, an omission is dichlorodicyanobenzoquinone ; and there is no reference to Jackman's useful review of hydrogenation-dehydrogenation reactions.

A few typographical errors have been noticed such as 'phenanthrene' for "phenanthraquinone" (p. 173), and 'Baly' for "Bally" (p. 189). The Scholl condensation, undoubtedly the most valuable reaction for the synthesis of polycyclic quinones, has been treated very briefly and there is no discussion of its mechanism in contrast with Balaban and Nenitzescu's chapter on the Scholl reaction in Olah's *Friedel-Crafts and Related Reactions*. These omissions are mentioned merely as suggestions for inclusion in a future edition which is sure to be called for in a short time, because of the wide interest of polycyclic hydrocarbons in general organic chemistry, dyestuff chemistry, and cancer,

Clar's two volumes represent a massive contribution to the literature of organic chemistry and they will find a place in all institutional libraries and in the personal libraries of many organic chemists.   K. V.

Evaluation of Drug Activities—Pharmacometrics (Vols. I and II). By D. R. Laurence, and A. L. Bacharach. (Academic Press, Inc., London W. 1.) Vol. I : Pp. xvii + 456. Price 90 *sh.* ; Vol. II : Pp. vii + 457–900. Price 95 *sh.*

Fifty-six authors who are intimately connected with pharmacological or allied departments and research centres have contributed to the forty-one chapters of this two-volume treatise on "Evaluation of Drug Activities". The objective of this book, as explained in the editorial Preface, is to provide a review and critical discussion of general and special pharmacological techniques used in the research for new drugs. The emphasis is on comparative evaluation of drug activity as the sub-title "pharmacometrics" implies.

General considerations of procedure, technique and evaluation of drug activities are discussed in the first seven chapters under the heads : First clinical trials of potential drugs ; A plan for evaluating potential drugs ; Design, statistical analysis and interpretation ; Strain and sex differences in response to drugs ; Some limitations of animal tests ; Toxicity tests ; and Drug dependence. These chapters will be of particular interest to those who are concerned with organising or conducting initial clinical and therapeutical trials of potential new drugs.

The other thirty-four chapters deal with individual kinds of drug activity as characterized by the nature of the target organ or tissue to be affected. Thus there are chapters on Analgesics and anæsthetics, anticonvulsants and cardioactive agents, tranquillisers, sedatives and hypnotics, diuretics, dermatological agents, blood cholesterol depressants, etc.

The book will be of great use not only to pharmacologists but also to workers in allied disciplines connected with pharmacometric measurements, such as biologists, biochemists, and physiologists.   A. S. G.

Structure of Matter. By Wolfgang Finkelnburg. (Academic Press, Inc., New York), 1964. Pp. xii + 511. Price $ 14.50.

This book is a translation of the tenth edition of the author's popular book in German *Einfuhrung in die Atomphysik* originally published in 1948. It gives a clear and systematic account of our present knowledge of the structure of matter, its constituent elementary particles, their properties and reactions. The first four chapters on Atoms, Atomic Structure, Atomic Spectra and Quantum Mechanics follow the well-known text-book on the subject like Sommerfeld, White, Condon, Herzberg and Born. Radioactivity and the physics of atomic nuclei and elementary particles are dealt with in the fifth chapter. This is followed by a chapter on Molecular Physics and Molecular Spectra. The last chapter is on Solid State Physics.

The book can be recommended as a suitable text-book in Modern Physics to the graduate and honours students of Physics.   A. S. G.

Selected Topics in Modern Chemistry. (Chapman and Hall Ltd., 11 New Fetter Lane, London E.C. 4). 1965. Each book about 120 Pp. Price 10 *sh.* 6 *d.* each.

The Pocket Books in this new series *Selected Topics in Modern Chemistry* being issued by the well-known publishers Chapman and Hall, Ltd., will provide teachers of chemistry in Higher Schools and Colleges with supplementary materials which will enrich the curricula and which are not generally elaborated in routine text-books. The topics selected are those in which there have been significant advances in recent years and as such will enthuse the reader with the spirit of modern researches in chemistry. The authors who have been invited to write have not only experience in teaching, but also have made original researches in the subjects of their writing. The presentation in each topic lays emphasis on basic concepts and gives a clear insight into the principles and applications.

The series editors are Professor Harry H. Sisler and Professor Calvin A. Vanderwerf. Each pocket book is about 100 pages and the price is 10 *sh.* 6 *d.* The following titles have come out in March 1965, with other titles to follow : (1) Electronic Structure, Properties and the Periodic Law, by H. H. Sisler ; (2) Modern Chemical Kinetics, by H. Eyring and E. M. Eyring ; (3) Acids, Bases and the Chemistry of the Covalent Bond, by C. A. Vander Werf ; (4) Chemistry in Non-Aqueous Solvents, by H. H. Sisler ; (5) An Introduction to Molecular Kinetic Theory, by J. L. Hilderbrand ; (6) Chemical Bonding and the Geometry of Molecules, by G. E. Ryschkewitsch ; (7) Organometallic Chemistry, by E. G. Rochow ; and (8) The Chemistry of Lanthanides, by T. Moeller.

A. S. G.

The Fundamental Particles. By C. E. Swartz. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A.), 1965. Pp. xiii + 152. Price $ 1.95 (paper bound).

In this small book of about 150 pages, the author, who himself was associated with the Brookhaven National Laboratory in his researches on particle physics, accelerator technology, and nuclear instrumentation, summarizes our present knowledge of the fundamental particles and their properties, the laws governing their interactions and behaviour under the influence of the various types of forces. Illustrations are very suggestive of the underlying ideas, and the plates on particle tracks reproduced in the text are excellent. Appendices contain brief descriptions of the principles of high energy accelerators, and particle detectors.

The somewhat popular exposition of a difficult and growing subject will be welcomed by students and teachers of Modern Physics.

A. S. G.

Ultrasound Physical, Chemical and Biological Effects. By Isaak Efimovich El'piner (Published by Consultants Bureau, New York), 1964, Pp. 371. Price $ 22.50.

The book provides a comprehensive review of progress in the understanding and application of the effects of ultrasonic waves on living objects and biologically active substances. The book is intended not only for biologists and biophysicists, but also for scientific workers in the fields of acoustics, physical chemistry, and chemistry and it will unquestionably be found very useful by them. The scope of the book will be understood from the titles of eleven chapters given as follows : (1) Elementary Physics of Ultrasonic Waves ; (2) Basic Ideas on the Mechanism of the Physical and Chemical Action of High-Intensity Ultrasonic Waves ; (3) Ultrasonic Luminescence ; (4) Effect of Nature of Gas on Ultrasonic Chemical Reactions ; (5) Action of Ultrasonic Waves on Organic Compounds ; (6) Physico-chemical Action of Ultrasonic Waves on Macromolecules ; (7) Action of Ultrasonic Waves on Biomacromolecules ; (8) Emulsification Processes in an Ultrasonic Field ; (9) Action of Ultrasonic Waves on Micro-organisms, Viruses, and Bacteriophages ; (10) Action of Ultrasonic Waves on Unicellular and Multicellular Organisms and (11) Acoustic Parameters and Ultrasonic Visualization of Organs and Tissues of Man and Animals.

C. V. R.

Books Received

Medicinal Chemistry, A Series of Monographs (Vol. 4, No. 1)—Psychopharmacological Agents. Edited by M. Gordon. (Academic Press, New York), 1964. Pp. xvi + 673. Price $ 23.50.

Advances in Computers. Edited by F. L. Alt and M. Rubinoff. (Academic Press, New York), 1964. Pp. xiii + 397. Price $ 14.00.

Methods in Computational Physics (Vol. 3)—Advances in Research and Applications. Edited by B. Alder, S. Fernbach and M. Rotenberg. (Academic Press, New York), 1964. Pp. xii + 386. Price $ 13.50.

The Epidermis. Edited by W. Montagna and W. C. Lobitz, Jr. (Academic Press, New York), 1964. Pp. xx + 649. Price $ 15.00.

Continuous Cultivation of Micro-organisms. Edited by I. Malek K. Beran and J. Hospodka. (Academic Press, New York), 1964. Pp. 391. Price $ 14.50.

The Physiology of Insecta (Vol. III). Edited by M. Rockstein. (Academic Press, New York), 1964. Pp. xiv + 692. Price $ 25.00.

Structure of Matter. By W. Finkelnburg. (Academic Press, New York), 1964. Pp. xii + 511. Price $ 14.50.

Advances in Control System—Theory and Applications (Vol. I). By C. T. Leondes. (Academic Press, New York), 1964. Pp. x + 365. Price $ 13.00.

Advances in Clinical Chemistry (Vol. VII). Edited by H. Sobotka and C. P. Stewart. (Academic Press, New York), 1964. Pp. xiv + 522. Price $ 16.50.

Physiological Mammalogy (Vol. II)—Mammalian Reactions to Stressful Environments. Edited by W. V. Mayer and R. G. van Gelder. (Academic Press, New York), 1965. Pp. xii + 326. Price $ 11.50.

Optical Properties of Minerals—A Determinative Table. by H. Winchell. (Academic Press, New York), 1965. Pp. ix + 91. Price $ 5.00.

Advances in Morphogenesis (Vol. IV). By M. Abercrombie and J. Brachet. (Academic Press, New York), 1964. Pp. x + 287. Price $ 12.00.

Advances in Organometallic Chemistry (Vol. II). Edited by F. G. A. Stone and R. West (Academic Press, New York), 1964. Pp. ix + 440. Price $ 15.00.

The Problem of the Minimum of Quadratic Functional. By S. G. Mikhlin. (Holden-Day Inc., Amsterdam), 1965. Pp. ix + 155. Price $ 8.95.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Sri Venkateswara University, Tirupati, has awarded the Ph.D. Degree in Physics to Messrs. P. Babu Rao and K. Chandrasekhara Reddy for their theses entitled "Molecular Constants of Certain Polyatomic Molecules" and "Ultrasonic Studies in Liquid Mixtures" respectively; Ph.D. Degree in Mathematics has been awarded to Sri. P. S. Rau for his thesis entitled "Geometrisation of Dynamics".

Ninth Indian Standards Convention

The Ninth Indian Standards Convention will be held at Bangalore from 13 to 18 December 1965.

The Technical Sessions will deal with the following subjects : (1) Expediting Preparation of Indian Standards; (2) Cost Reduction Through Standardization; (3) Extending Usefulness of ISI Certification Marks; (4) Implementation of Agricultural and Food Standards ; (5) Standardization in the Field of Welding ; (6) Crisis of Shortage of Building Materials ; (7) Overseas Collaboration and Standardization in India; (8) Documentation and Library Housing.

Papers submitted, which will be subject to acceptance, should have a direct bearing on some related aspect of standardization in the fields covered by the sessions. The synopses of the papers should reach by 15 July and the full text by 15 August 1965.

All letters and other correspondence in connection with this Convention may kindly be marked 'Ninth Indian Standards Convention' on the envelope and addressed to : Shri B. L. Bhatia, Organizing Secretary, Ninth Indian Standards Convention, 'Manak Bhavan'; 9, Bahadur Shah Zafar Marg, New Delhi-1.

FAO World Symposium on Warm-Water Pond Fish Culture

The Eleventh Conference of FAO gave its approval for holding a World Symposium as an important step in furthering international action for the advancement of fish culture. The subject being too wide to be covered in one symposium, the Fisheries Division of FAO, in accordance with the recommendations of a consultative panel, has decided to convene a symposium to cover the culture of warm-water fishes in ponds for food. The Symposium will therefore discuss selected aspects of culture of fishes such as the carps and tilapias—generally excluding cold-water species such as the salmons, trouts, and coregonids.

The Symposium will be held at the Headquarters of FAO in Rome from 18 to 25 May 1966.

For further details and Nomination Forms please write to T. V. R. Pillay, Secretary, FAO World Symposium on Warm-Water Pond Fish Culture, Fisheries Division, FAO of the United Nations, via delle Terme di Caracalla, Rome, Italy.

Precambrian Flora

Elso S. Barghoorn of Harvard University reporting on the extensive study of the fossil-rich Gunflint charts of Ontario by himself and the late Stanley A. Tyler, has described eight hitherto unknown genera of organisms that flourished in the shallow waters of that region in Middle Precambrian times. Seven of the eight were almost certainly plants analogous to, although not related to, the various photosynthetic blue-green algæ that inhabit aquatic environments today. The eighth, a more advanced organism, remains an enigma. In basic organization it is reminescent of such coelenterates as the hydra, but its tiny size—some 30 microns in length at maximum—seems to rule out its admission to that phylum of the animal kingdom.

The Gunflint fossils owe their preservation to an unusual sequence of events. The waters they inhabited were evidently rich in dilute silica ; when unknown causes precipitated this silica as a gel, the organisms were entrapped. Eventually transformed into the mineral opal through dehydration, the former gel provided its chance enclosures with the protection of an almost incompressible matrix. This matrix crystallized into the chalcedony and quartz of which the Gunflint charts are composed but escaped the kind of metamorphosis under heat and pressure that has apparently destroyed the fossil content of most other Precambrian sediments. According to Borghoorn this accident of preservation "is a window through the Precambrian metamorphic veil".—(Sci. Amer., April 1965.)

THE NEW PHYSIOLOGY OF VISION
Chapter XX. Superposition and Masking of Colours

Sir C. V. RAMAN

THE following questions of a fundamental nature arise in the theory of colour. If two beams of monochromatic light of different colours are perceived by our eyes simultaneously, what would be the resulting sensation and how would it depend on the relative brightness of the two beams ? An answer to these questions is needed for every possible pair of colours in the spectrum. If it is forthcoming, it would furnish material for a fuller understanding of the phenomena we are confronted with in the synthesis of colour, a subject which has been dealt with in the two preceding chapters. Observational studies are necessary which would enable the questions raised above to be answered. They will be described and the results obtained will be discussed in the present chapter.

The Method of Superposed Spectra.—A very simple technique by which the effect of superposing monochromatic light from two different parts of the spectrum can be ascertained is to use two linear light sources held parallel to each other and for the observer to view the diffraction spectra of the two sources simultaneously with a replica grating held in front of his eye. The two sources may be two similar lamps or two illuminated slits held at a convenient distance apart which can be varied as desired. The first-order diffraction spectra of the two sources are then seen superposed but in displaced positions with respect to each other. If one of the sources is placed at a slightly higher elevation than the other, the superposition is effective over the greater part of the width of the two spectra, but a little of each spectrum would project beyond the other, thereby enabling the observer to notice the two colours which are superposed at any point in his field of view. By appropriate methods, *viz.*, by varying the electric current through the tubular lamps or by varying the width of the illuminated slits, the relative brightness of the two sources can be altered. By changing the separation between the two sources or by the observer moving towards or away from them, the displacement of the spectra with respect to each other can be varied to any desired extent. The colours seen in the overlapping parts of the two spectra can then be readily compared with those seen in the non-overlapping regions.

Observations made in the manner described make it evident that the visible spectrum extending over the range of wavelengths from 7000 A.U. to 4000 A.U. falls into two divisions. The first division from 7000 A.U. to 5000 A.U. covers the red, yellow and green sectors of the spectrum, while the second division from 5000 A.U. to 4000 A.U. is the blue sector, including in this term the regions where blue, indigo and violet are observed either in different parts or at different levels of brightness, as the case may be. Each of these two divisions of the spectrum has the property that any two monochromatic radiations selected from different parts of it when superposed results in a chromatic sensation of the same nature as is to be found within that division, its position, however, being dependent on the relative brightness of the two superposed radiations. If, for example, we superpose monochromatic light which exhibits a red colour upon another which appears green, the resultant would be one or another of the intermediate colours in the spectrum, the position of which would be determined by the relative intensity of the two superposed radiations as indicated by the formula :

$$n_1 h \nu_1 + n_2 h \nu_2 = (n_1 + n_2) h \nu_3$$

The formula states that the energy as well as the number of corpuscles perceived is a summation of their respective values for the superposed radiations. It follows from this assumption that the resultant would be perceived as light of frequency ν_3 which is intermediate between ν_1 and ν_2 and is nearer one or the other according as n_1 is greater or less than n_2. The formula assumes that the more intense radiation does not mask the weaker radiation thereby preventing its influence being felt in the final result. There is observational evidence, however, that such masking does occur when one of the superposed radiations is much more intense than the other.

The reason why the spectrum falls into two chromatic divisions in the manner indicated above is not far to seek. In the first division, as has been set out in earlier chapters, the visual pigments are chemically of the same nature, *viz.*, heme, but in different states of oxidation and their absorption spectra overlap.

In these circumstances it is to be expected that they would co-operate in the reception of poly-chromatic radiation and enable it to be perceived as a monochromatic sensation. The position is entirely different when the radiations which are superposed belong to the two different divisions of the spectrum. The visual pigment in the second division is of a different nature, *viz.*, a carotenoid. Further, the two divisions of the spectrum represent light-corpuscles of widely different energies. It could scarcely be expected in these circumstances that the chromatic sensations associated with mono-chromatic radiations from the two different divisions should be coherent and be perceived as a single monochromatic sensation.

The foregoing remarks indicate that the super-position of a monochromatic radiation selected from the blue sector of the spectrum upon a radiation selected from the red, yellow or green sector would result in the production of colour sensations of a distinctive character. This is found to be actually the case when the matter is investigated by the method of super-posed spectra described above. As the blue sector of one spectrum successively traverses the red, yellow and green sectors of the other spectrum, beautiful and striking changes are noticeable in the colours of the superposed spectra, the colours observed being quite different from the monochromatic sensations which are superposed on each other. We shall later return to a detailed description of these effects. Presently, we shall proceed to consider from first principles the phenomena which may be expected to manifest themselves in such cases.

Theoretical Considerations.—The most natural assumption to make regarding the sensation excited by two monochromatic radiations of widely different frequencies ν_1 and ν_2 when superposed is that it can be represented by a formula of the type

$$n_1 h \nu_1 + n_2 h \nu_2 = n_1 h \nu_3 + n_2 h \nu_4$$

The formula assumes that both the energy and the number of light-corpuscles perceived when the radiations are superposed are simple summations of these quantities for the two radiations considered separately. It is postulated, however, that the superposition can result in an alteration of the frequencies of the perceived radiations. The equation contains two unknowns, *viz.*, ν_3 and ν_4, with only one equation connecting them. It follows that the values of ν_3 and ν_4 are not exactly definable, but that they can range over wide tracts in the spectrum. If

the ranges of variation of ν_3 and ν_4 are sufficiently large to cover the entire visible spectrum, the resulting sensation would be more or less perfectly achromatic, in other words, it would resemble white light. Whether this result actually manifests itself would depend on the particular circumstances of the case. Of special importance in this respect would be the relative intensity of the two superposed beams. If, for example, n_1 is very large compared with n_2, the resultant sensation would evidently approach the monochromatic colour of ν_1. *Vice-versa*, if n_2 is large compared with n_1, the perceived sensation would resemble the colour of ν_2. More generally, however, the sensation would resemble neither the one nor the other and would largely be determined by the continuous spectrum of perceived frequencies.

The considerations set forth above give us an intelligible explanation of a well-known fact of experience, *viz.*, the existence of what are known as complementary colours in the visible spectrum. The complementarity manifests itself as between two regions in the spectrum widely separated from each other, one in the region between 700 mμ and 560 mμ, in other words, in the red and yellow sectors of the spectrum and the other in the blue sector of the spectrum between 500 mμ and 400 mμ. If radiations suitably selected from these two regions and having the appropriate relative intensities are superposed, the resulting sensation is that of white light. Such complementarity is exhibited when the two superposed beams have comparable luminosities, if one of them is located in the orange-yellow at about 600 mμ and the other in the blue-green region at about 490 mμ. In these circumstances, it would evidently be possible for the spread-out of the perceived frequencies of the two components to result in the entire visible spectrum being covered, and hence to result in the perception of an achromatic sensation.

Confirmatory Observations.—A convincing demonstration can be given that the process envisaged in the preceding theoretical discussion actually occurs, *viz.*, that the superposition of two monochromatic radiations of widely different frequencies results in each of them being perceived spread out into a spectral band of frequencies. For this purpose, two highly monochromatic light-sources of which the colours are far apart in the spectrum may be selected. A suitable choice for one is the violet λ 4358 radiation from a mercury vapour lamp.

This may be readily isolated from its other radiations by using a fairly strong solution of cuprammonium as a light filter. For the other, a suitable choice is the orange-yellow light of wavelengths λ 5890–5896 furnished by a sodium vapour lamp. Light from these two sources may be projected with the aid of apertures and lenses to appear as luminous circles on a white screen. The region where the two circles overlap is observed to exhibit a vivid rose-red colour, in striking contrast with the violet and orange-yellow colours of the non-overlapping regions.

As has been shown by several examples in earlier chapters, a rose-red colour results from the removal of the green sector ranging from 500 mμ to 560 mμ from white light, while the rest of the spectrum, including especially the blue sector from 400 mμ to 500 mμ remains of undiminished brightness. Thus, what is actually observed in the experiment indicates that the superposition of the violet and orange-yellow radiations has resulted in the former being perceived as a spectral band covering the blue sector and of the latter being perceived as a spectral band covering the red and yellow sectors of the spectrum. This interpretation of what is observed receives confirmation from the observed result of projecting on the same screen, the λ 5461 radiations of another mercury arc isolated with the aid of colour filters of disulphine-blue and acridene-orange. Where the circle of green light thus obtained overlaps the rose-red region, the area appears achromatic. On the other hand, in the region of overlap of the green and violet, the perceived colour is a pale bluish-white. Where the green circle overlaps the circle of orange-yellow light, we perceive a bright lemon-yellow colour.

In the experiment described above, we may use, instead of the orange-yellow light from a sodium lamp, red light from the extreme end of the spectrum at 700 mμ which may be isolated from white light by passing it through a dense filter of methyl-violet and another filter of acridene-orange. It is then noticed that where the circle of red light obtained in this fashion overlaps the circle of violet light from the mercury lamp, the colour observed in the region is *not a purple* but a rose-red similar to that obtained by the superposition of orange-yellow and violet. Likewise, in the present case, the rose-red colour of the region of overlap may be achromatised by the superposition of green light isolated from the radiations of a mercury lamp.

A similar experiment may also be performed using the violet λ 4358 radiation from one mercury lamp and the yellow λ 5770–5790 radiations from another mercury lamp isolated with the aid of colour filters of eosine and acridene-orange. When the circles of violet and yellow light thus obtained are projected on a white screen, the region of their overlap appears of a rose-red colour. But this does not present such a saturated hue as in the other cases.

The Colours in Superposed Spectra.—We now return to the subject of the colour sequences observed when two diffraction spectra are superposed upon each other in displaced positions as in the manner explained earlier. This technique is particularly useful in the study of colour superposition, since it enables us to observe the entire region of overlap between the spectra at a glance and to compare the colours noticeable at different points in the region and also to observe how they alter as the spectra are progressively displaced with respect to each other. The influence of varying the relative intensities of the two spectra can also be very conveniently studied.

Of particular significance and interest is the fact that the boundary at about 500 mμ between the green and the blue in the individual spectra manifests itself as a highly pronounced discontinuity in colour in the overlapping regions of the two spectra. Extremely conspicuous, for example, is this discontinuity when the blue sector of one spectrum overlaps the orange-red, orange and orange-yellow regions in the other spectrum. The overlapping region appears as a brilliant rose-red band of colour with a sharply defined edge on one side corresponding to the green-blue boundary of the first spectrum. The colour changes sharply from a rose-red to a bright greenish-yellow at the boundary. On the other side of the rose-red band, one can observe a narrow region of the spectrum which is nearly achromatic and corresponds to the point where the yellow of the second spectrum overlaps the blue of the first.

The discontinuity in the colour sequence persists when the two spectra are displaced with respect to each other from the position stated above, but the colours observed on either side of it are naturally then different. If, for example, the blue sector of one spectrum overlaps the green sector of the second, the region of such overlaps appears of a bluish-white colour, sharply differentiated from the orange-yellow on the other side of the discontinuity arising from the overlap of the green sector of the first spectrum with the red sector of the second.

THE MEASUREMENT OF RADIOCARBON ACTIVITY AND SOME DETERMINATIONS OF AGES OF ARCHAEOLOGICAL SAMPLES

D. P. AGRAWAL, SHEELA KUSUMGAR AND D. LAL

Tata Institute of Fundamental Research, Colaba, Bombay-5

IN this paper, we present several radiocarbon dates of India based on archæological samples, measured recently using a modified technique. So far, we had adopted the acetylene-gas proportional counting method developed by Suess (Suess, 1954). The preparation of acetylene, or of some suitable gas which offers good counting-characteristics, from the carbon atoms of the samples, is a necessary requirement for a sensitive counting of the activity of radiocarbon. The maximum energy of its beta-radiation is only 156 KeV and the solid source method of counting entails considerable errors and lack of precision. We have now developed a simple, rapid and quantitative method of synthesising methane gas from carbon atoms of the sample to be dated. The technique used is described briefly in this paper. Results of determination of fifteen "dates" of archæological samples are also presented.

Previous determinations of radiocarbon "dates" of samples of archæological and geological interest have been reported by us in three communications to this Journal (Agrawal *et al.*, 1964 *a*, 1964 *b*; Agrawal and Kusumgar, 1965). The "dates" are also presented annually in the Journal *Radiocarbon* which carries the results of world C¹⁴-laboratories (Kusumgar *et al.*, 1963 *a*; Agrawal *et al.*, 1964 *c*).

SYNTHESIS OF METHANE

The technique is an adaptation of the methane synthesis method developed by Anand and Lal (1964) for purposes of counting tritium activity. Methane is synthesised from carbon dioxide gas produced from the sample carbon in a reaction vessel according to the following *effective* reaction:

$$CO_2 + 2 H_2O + 4 Zn = CH_4 + 4 ZnO \qquad (1)$$
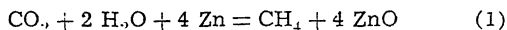
Water and zinc react at 410°–420° C. to produce hydrogen which, in the presence of a catalyst (0·5% Ru on Al_2O_3), forms methane at > 475° C., by the following reaction with CO_2:

$$CO_2 + 4 H_2 = CH_4 + 2 H_2O \qquad (2)$$
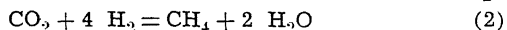
The reaction (2) has been used for purposes of counting radiocarbon activity (Fairhall *et al.*, 1961), using commercially available hydrogen. For our synthesis, we have preferred to use

the reaction (1) since the hydrogen available to us was found to have enough tritium to give a net increase of more than one count per minute in the background rate. Tritium-free water, which provides the hydrogen atoms in the synthesised methane, was easily available to us from the tube-well at Chanasma (Gujarat). Its tritium activity was determined to be less than 1 T.U. which is expected to give an increase of not more than 0·02 c.p.m. in the background counting rate.

In order to make the reaction (1) quantitative, we use about 10% excess of water. The synthesis is carried out in a stainless steel reaction vessel (Fig. 1) of diameter 10 cm., and length 100 cm. Zinc dust (B.D.H.) and Baker's ruthenium catalyst* (Model E) are placed in dishes mounted on a self-supporting rod. Required amount of water is taken in a glass ampoule which is sealed and then mounted alongside the rod as shown in Fig. 1. The two furnaces are energised so as to raise temperatures of zinc and catalyst to 410°–420° and 490°–500° C. respectively. Typical proportions of the reactants are: 6·3 litres CO_2 (S.T.P.), 11 c.c. H_2O and 400 gm. zinc dust. Fifty grams of catalyst is taken which could be used satisfactorily for 12-14 syntheses. The reaction products are usually taken out after 15-20 hr. of energising the furnaces.

The purification of methane is carried out in a glass vacuum system shown in Fig. 1. Excess unconverted water is trapped in T_0, kept at carbon dioxide-acetone slush temperature. The gases were then absorbed in liquid-air-cooled traps T_1, T_2 and T_3. Any traces of unconsumed CO_2 are trapped entirely in T_1 and T_2. Methane, which is initially trapped in T_1 and T_2, finally distils over to T_3, since it has a vapour pressure of about 1·5 cm. Hg at liquid-air temperature. The vapour pressure of methane in T_3 which contains about 50 gm. high grade silica gel† (mesh size 12-28) is only a few microns. Pumping on T_3 for an hour with a liquid-air-cooled activated charcoal trap, T_4, removes all

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* Baker Platinum Division, Engelhard Industries Ltd., 52, High Holborn, London, W.C. 1.

† Davison Chemical, Baltimore, 3 Maryland.

traces of hydrogen present in the mixture. Synthesised methane is then distilled from trap T_3 to the liquid-air-cooled trap T_5 and expanded into a 10-litre flask. The completeness of the reaction is gauged by expanding the CO_2 found in traps T_1 and T_2 in a 5-litre flask. The amount of CO_2 left unconverted is usually found to be less than 5 c.c. (S.T.P.), corresponding to an yield of better than 99·9%.

COUNTING OF THE RADIOCARBON ACTIVITY

Two low-background Oeschger-Houtermans gas proportional counters (Houtermans *et al.*, 1957), of 2·7 litres volume, are used. The counters are filled with methane to pressures of 115 and 90 cm. Hg respectively to meet the requirements of archæological dating. Relevant counting characteristics are given in Table I.
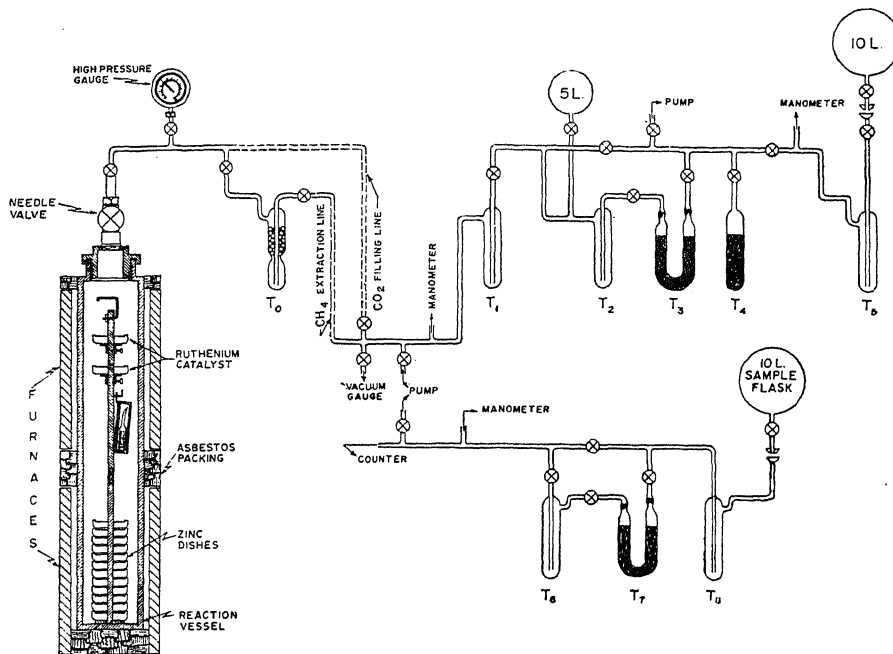
FIG. 1. A schematic diagram of methane synthesis and purification systems.

Before filling methane in the counter, a second purification of the sample gas is carried out. Methane is first trapped in liquid-air-cooled charcoal-silica gel (1 : 3 by volume) trap, T_7, and then allowed to distil over to liquid-air-cooled trap, T_6, by warming up T_7 to room temperature. A further purification is carried out by pumping on trap T_6 for fifteen seconds (Fig. 1).

We have not discussed here the method used for the preparation of CO_2. The details of pretreatment of the sample and the generation of CO_2 from it have been described by Kusumgar *et al.* (1963 b). We still follow those procedures. However, additional purification steps for purification of CO_2 from any traces of H_2S, NO_2, N_2O_5, etc., have been introduced. CO_2 is passed successively through an aqueous solution of 0·1 M $KMNO_4$ containing 2% H_2SO_4, silver wool at 300° C. and a charcoal-silica gel trap kept at room temperature.

TABLE I

	Counter I	Counter II
Filling pressure (cm. Hg) ..	115	90
Operating voltage	4·7 KV	4·4 KV
Background counting rate (c.p.m.) (Methane synthesised from "dead" carbon)	1·5	1·5
C^{14}-standard counting rate (total c.p.m.) (Methane synthesised from N.B.S. oxalic acid)	15·2	12·8

The effective amount of carbon counted in counters I and II is 0·91 gm. and 0·75 gm. respectively. Though the gas-filling pressure is higher by about a factor of two compared to that used previously by us for acetylene (Kusumgar *et al.*, 1963 b) the sensitivity is nearly the same since each molecule of methane contains only one carbon atom in contrast to acetylene which has two atoms per molecule. Higher gas pressures with methane, however, still provide low-operating voltages and it is

conveniently possible to increase the precision of the measurement by working at higher filling pressures. However, normally archæological samples are available in small quantities only and therefore low-filling pressures were employed.

Main advantages in using the present method of methane counting over acetylene are: (*a*) rapid synthesis; (*b*) preparation of radon-free gas; and (*c*) the non-explosive nature of methane. With the acetylene method, steps for the preparation of strontium carbonate, strontium carbide, and acetylene usually took several days. It also was necessary to let the samples decay for a period of three weeks to make them free of radon activity. In the present system, the entire synthesis takes a day and no "wait" for decay of radon was found to be necessary.

The methane synthesis technique described above was adopted routinely since September 1964. Since then, six C^{14}-standard and seven background samples were prepared and counted. The counting rates were found to be the same within the statistical errors of measurements showing reproducibility both in counting as well as synthesis.

RESULTS

The measured "dates" of archæological samples collected from the neolithic sites of the south, and a few N.B.P. Ware sites of the north are presented.‡ The dates are based on a value of 95% activity of the N.B.S. C^{14}-standard, for the modern C^{14}/C^{12} ratio. Two dates are given for each sample. The first one is calculated on the basis of 5568 ± 30 yrs. for the half-life of radiocarbon; the second date, given within brackets, is based on 5730 ± 40 yrs. for the C^{14} half-life. All dates are in years B.P.; to convert them to A.D./B.C. scale, 1950 A.D. should be used as the reference year.

For archæological evaluation, all "dates" based on one of the values for C^{14} half-life should be used.

ACKNOWLEDGEMENTS

C^{14} DATES WITH SAMPLE DESCRIPTIONS

Besnagar, Madhya Pradesh, India

TF-254, N.B.P. Ware Deposits, 2180 ± 105   *(2245 $\pm$ 110)*

Charcoal from Besnagar (Lat. 23° 32' N., Long. 77° 48' E.), District Vidisha, Trench BSN-I, Layer 8, Depth 2·70 m., Field No. BSN-I/ GI/C/64-2. Sample submitted by A. Ghosh. Comment: The sample belongs to early phases of N.B.P. Ware at the site.

Bhaja, Maharashtra, India

TF-170, Buddhist Rock-Excavations, 350 ± 115   *(360 $\pm$ 115)*

Wood from "the girders supporting an arched roof", Bhaja (Lat. 18° 44' N., Long. 73° 29' E.), District Poona. NaOH treatment was also given. Submitted by Dr. K. A. Chowdhury. Comment: The sample was dated to help botanical studies on the decay of cell-walls. The divergent date is attributed by the submitter to the probability of the sample being derived from later repairs.

Karla, Maharashtra, India

TF-171, Buddhist Rock-Excavations, 2075 ± 100   *(2135 $\pm$ 100)*

Wood "from an inside rib fitted to the wall of a rock cave", Karla (Lat. 18° 45' N., Long. 73° 29' E.), District Poona. NaOH pretreatment was also given. Submitted by Dr. K. A. Chowdhury. Comment: The sample was dated to help botanical studies on cell-wall decay. Compare with BM-92, 2305 ± 155 (Barkar and Mackey, 1961) for the same structures.

Kausambi, Uttar Pradesh, India

Kausambi (Lat. 81° 23' N., Long. 25° 20' E.), now known as Kosam, District Allahabad, is situated on the bank of Yamuna. It is known as the capital of the later Pandavas. The site is being excavated by the Allahabad University under the direction of Prof. G. R. Sharma who submitted the samples.

TF-226, Rampart II, 2110 ± 95   *(2170 $\pm$ 100)*

Charcoal sample from Trench KSB-GR, Locus YZ3, 1-2, Layer 12, Depth 1·8 m., Field No. KSB/63/GR-138. Comment: The excavator's archæological date bracket for the sample is ca. 535-185 B.C.

TF-219, Period III, 2325 ± 100
(2390 ± 100)

Charcoal from Trench KSBI-III-RD, Locus 2-7, Road I, Depth 3 m., Field No. KSB/63/AP-9. Comment : the sample has been attributed to the middle levels of N.B.P. Ware at the site.

TF-225, Period III, 2285 ± 105
(2350 ± 110)

Charcoal from Trench KSB-GR, Locus YZ3, 1-2, Layer 11, Depth 1·6 m., Field No. KSB/63/GR-136. Comment : The sample has been assigned to the early levels of N.B.P. Ware at the site.

TF-221, Period III, 2385 ± 100
(2450 ± 105)

Charcoal from Trench KSB-I-III-RD, Locus 5-7, Pit B sealed by Layer 12, Depth 4·3 m., Field No. KSB/63/AP-15. Comment : The excavator's date on archæological considerations is ca. 400 B.C.

Mahanadi Bridge, Orissa, India
TF-252, Mahanadi River-Bed, 5815 ± 140
(5985 ± 145)

Drift wood from well No. 8, Depth 39 m., excavated during railway bridge construction work. NaOH pretreatment was also given. Submitted by K. Ramesh Rao, F.R.I., Dehra Dun.

Pataliputra, Bihar, India
TF-169, Wooden Palisades, 2005 ± 95
(2005 ± 100)

Wood from the Palisades of Kumrahar, from a depth of 5·4 m. NaOH pretreatment was also given. Submitted by Dr. K. A. Chowdhury. Comment : The sample archæologically datable to Mauryan Period and was measured to help botanical studies on the decay of cell-walls.

Rajghat, Uttar Pradesh, India
TF-294, Black and Red Ware Deposits, 2190 ± 85
(2255 ± 90)

Charcoal from Rajghat (Lat. 25° 18′ N., Long. 83° 1′ E.), District Varanasi, Mound I, Trench RGT-XIA, Locus X-XI, Layer 14, Depth 11 m., Field No. RGT-XIA 1963-64/S. No. 4. Submitted by A. K. Narain. Comment : Sample derives from disturbed strata.

Rupar, Panjab, India
TF-209, Period III, 2365 ± 100
(2435±100)

Charred wood from Rupar (Lat. 30° 58′ N., Long. 76° 32′ E.), District Ambala, Trench RPR-2, Locus X′-XI′, Layer 30, Depth 11·4 m., Field No. RPR-2-3094. Submitted by A. Ghosh. Comment : Sample belongs to the early levels of Period III (ca. 500-400 B.C.) according to the excavator, Dr. Y. D. Sharma.

Tekkalakota, Mysore, India

Tekklakota (Lat. 15° 32′ N., Long. 76° 53′ E.), District Bellary, is an extensive neolithic site. The site was excavated by Deccan College and Post-Graduate Research Institute under the direction of H. D. Sankalia who submitted the samples. Comment : The radiocarbon dates show that Tekklakota represents a later phase of neolithic economy. Unlike Utnur, whose antiquity goes to the close of III millennium B.C. (B.M. 54, 4250 ± 155) (Barkar and Mackey, 1960); TF-168, 3990 ± 115 ; TF-167, 4000 ± 115), available Tekklakota C[14] dates suggest a bracket of ca. 1800-1600 B.C. The three measurements from TKT-1 cluster around ca. 1600 B.C.

TF-277, Ash-Pit, 2220 ± 105
(2285 ± 110)

Charred grains from Trench A, TKT-GWD, Layer 2 ash-pit, Depth 0·3 m. NaOH treatment was also given. Comment (H. S. D.) : Archæological date uncertain as the sample is coming from an ash-pit.

TF-239, Neolithic Culture, 3395 ± 105
(3490 ± 105)

Charcoal from TKT-I, Trench I, Pit 4 sealed by 4, Depth 1·3 m. NaOH treatment was also given.

TF-237, Neolithic Culture, 3465 ± 105
(3565 ± 105)

Charcoal from TKT-I, Trench I, Layer 4, Depth 1 m. NaOH pretreatment was also given.

TF-262, Neolithic Culture, 3460 ± 135
(3560 ± 140)

Charcoal from TKT-I, Trench 9, Layer 1, Depth 0·25 m. (A few rootlets were present in the sample.) NaOH pretreatment was also given.

TF-266, Neolithic Culture, 3625 ± 100
(3730 ± 105)

Charcoal from TKT-II, Trench 2, Layer 2, Depth 0·17 m., Field No. 265. NaOH treatment was also given.

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SYNTHESIS OF SOME 2'-OXYGENATED FLAVONES*

V. V. S. MURTI, P. V. RAMAN AND T. R. SESHADRI

Department of Chemistry, Delhi University, Delhi-7

IN addition to 5, 6-dimethoxyflavone (I) three new flavones having 2'-methoxyl substituent have been reported to occur in the Mexican tree *Casimiroa edulis*.[1-3] These are 5, 6, 2'-trimethoxyflavone (II), zapotin (III) and zapotinin (IV). The structures of (I) and (II) were confirmed by comparison with synthetic compounds[4,5] but those of (III) and (IV) were inferred from spectral data, colour reactions and degradations and no comparison with synthetic substances was made.

I R = H
II R = OCH₃
III R = CH₃
IV R = H

We were interested in the structures assigned to zapotin and zapotinin for a number of reasons : (i) Work has been going on in our laboratory on the Wessely-Moser rearrangement of flavonoids, the factors which govern this change and the mechanism involved.[6,7] The three flavones mentioned above seemed to offer interesting possibilities for such a study.[8] (ii) The validity of the constitutions suggested for zapotin and zapotinin appeared to require synthetic confirmation for the following reasons : (a) Zapotin was reported to undergo only partial demethylation in the 5 position on fusion with potassium hydroxide,[1] a reaction known to effect fission of the pyrone ring and to bring about other drastic changes in flavonoids. (b) Salicylic acid and resorcinol were identified in the products of potash fusion of demethylzapotin[1]; while salicylic acid could be traced to the side-phenyl nucleus, the origin of resorcinol could not be definitely established.[3] (c) The oxygenation pattern of the A-ring of zapotin was inferred chiefly from the colour reactions of demethylzapotin, including Bargellini's test but no degradation product to substantiate this conclusion was isolated.[3] It is known

that this test is not specific for compounds of the 5, 6, 7-trihydroxy type and other substances also give a positive reaction.[9-13] It was, therefore, considered necessary to synthesise 5, 6, 7, 2'-tetramethoxyflavone and 5-hydroxy-6, 7, 2'-trimethoxyflavone by unequivocal methods and compare their properties with those of zapotin and zapotinin. This has now been done and, though direct comparison with the compounds isolated from *Casimiroa edulis* could not be carried out, the differences in the properties of the synthetic and the natural products make it clear that zapotin and zapotinin cannot have the structures attributed to them. Our work is still in progress ; however, in view of the recent publication of Farkas and Nogradi[14] our main findings are summarised here.

The starting material for the synthesis of 5, 6, 7, 2'-tetramethoxyflavone was 2-hydroxy-4, 5, 6-trimethoxyacetophenone[15]; this was esterified with o-methoxybenzoyl chloride[16] and the resulting ester was isomerised to the dibenzoylmethane using potassium hydroxide in pyridine solution.[17] Ring closure by boiling the diketone with sodium acetate in glacial acetic acid solution afforded the required tetramethoxyflavone. Partial demethylation of the latter with boiling 20% hydrochloric acid gave 5-hydroxy-6, 7, 2'-trimethoxyflavone and complete demethylation to 5, 6, 7, 2'-tetrahydroxyflavone was effected with hot hydriodic acid. The acetates of these compounds were prepared by the acetic anhydride-sulphuric acid method. Attempts were also made to prepare 5, 6, 7, 2'-tetramethoxy- and 5-hydroxy-6, 7, 2'-trimethoxyflavones from 5, 7, 8, 2'-tetramethoxyflavone using the Wessely-Moser rearrangement. The last substance was prepared from 2-hydroxy-3, 4, 6-trimethoxyacetophenone[18] following a route similar to the synthesis of 5, 6, 7, 2'-tetramethoxyflavone. Demethylation of the tetramethoxyflavone to 5-hydroxy-7, 8, 2'-trimethoxyflavone could not be effected with 20% hydrochloric acid but heating with aluminium chloride in nitrobenzene solution was successful. Complete demethylation to 5, 7, 8, 2'-tetrahydroxyflavone was carried out with aluminium chloride in boiling benzene. The acetates of these compounds were prepared by the same method as above. The m.p. and the

spectral properties of some of our compounds were different from those of Farkas and Nogradi[14]; however, the properties of 5, 6, 7, 2'-tetramethoxy- and 5-hydroxy-6, 7, 2'-trimethoxyflavones are markedly different from those reported for zapotin and zapotinin[1,3] thus showing that the latter cannot have the structures ascribed to them. The properties of 5, 7, 8, 2'-tetramethoxy- and 5-hydroxy-7, 8, 2'-trimethoxyflavones also do not agree with those of zapotin and zapotinin ruling out these alternative structures also.

Attempts to convert 5, 7, 8, 2'-tetramethoxyflavone to 5, 6, 7, 2'-tetrahydroxyflavone by prolonged refluxing with hydriodic acid and acetic anhydride led to inconclusive results. At one stage of our investigation it was considered possible that the product could be 2', 3', 4', 6'-tetrahydroxyflavone (cf. ref. 8). The corresponding tetramethoxyflavone was synthesised from o-hydroxyacetophenone and 2, 3, 4, 6-tetramethoxybenzaldehyde[19] (now prepared from 1, 2, 3, 5-tetramethoxybenzene[18] by the dimethylformamidephosphorus oxychloride method) *via* the chalcone and subsequent oxidation with selenium dioxide. But this compound was different from the complete methyl ether of the hydriodic acid demethylation product of 5, 7, 8, 2'-tetramethoxyflavone. Further work on this problem and attempts to determine the correct structures of zapotin and zapotinin is in progress.

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CARNEGIE INSTITUTION OF WASHINGTON—YEAR-BOOK 63 *

THE increased research activities of the various deparments of the Carnegie Institution of Washington during the year 1963-64 are at once apparent from the enlarged size of the Year-Book 63. The Report of President Caryl P. Haskins occupies 20 more pages than last year's, and the Departmental Reports occupy nearly 100 more pages than last year's. Dr. Haskins's thesis on "The Process of Planning Both in and for Science" is highly thoughtful and penetratingly analytical and demands careful study.

In the Mount Wilson and Palomar Observatories programmes of work during the year on solar observations, planets and comets, radio sources and galaxies have yielded some noteworthy results. An analysis of the isotope bands $C^{12}C^{13}$ in the spectrum of comet Ikeya (1963 a) taken with the 200-inch telescope has indicated a C(12)/C(13) ratio which is the same as in terrestrial and meteoritic material. This observation suggests that the cometary material came from the region of the terrestrial group of planets rather than from the region of the major planets, assuming, of course, that comets were formed at the same time as the solar system.

Earlier work had indicated that the chromospheric activity of a main-sequence star is

probably a decreasing function of time. Results obtained during the year have confirmed this. This opens up a fruitful field of work whereby intensities of bright H and K lines could be used to determine relative age groups of stars and thus provide information on the rate of star formation during past epochs. Continuation of work on globular clusters in the Milky Way centre has led to the conclusion that the size of the nucleus of our Galaxy is only about half the size of the nucleus of the Andromeda nebula, and consequently our own Galaxy should be classified as an Sc rather than an Sb system.

During the year the programme of optical identification of radio sources of the quasi-stellar type was continued. Exact optical location of quasars is based on the intense ultra-violet radiation of the sources as compared with their blue and yellow emission. The technique employed is a double-image photography with the 100-inch reflector or the 48-inch schmidt utilizing a blue and an ultra-violet filter. It has thus been possible to increase the list of definitely identified quasars from six to thirteen. The red-shift measurement $\triangle\lambda/\lambda = 0\cdot545$ for 3C147, confirmed during the year, shows that it is the most distant object known in the universe.

The report of the Geophysical Laboratory shows that a major fraction of the work during the year was devoted to basalt problems. Systematic investigations have revealed that the basalts can now be delineated into significant compositional groups, and their fractionation can be described in terms of a simple flow sheet. It is even possible that a single, although heterogeneous, magmatic source exists for them. The work of the isotope group of the Laboratory on the isotopic composition of lead in feldspars and galenas of various ages, suggests a new value for the age of the Earth (at least $4\cdot7 \times 10^9$ years) different from the currently accepted value of $4\cdot55 \times 10^9$ years. In the biogeochemical research the new amino-acid analyzer equipment providing increased sensitivity has been used in the study of proteins in molluscan shells. Chromatographic studies of hydrocarbons in Precambrian petroleum have shown some new and significant results.

In the Department of Terrestrial Magnetism geomagnetic investigations showed a remarkably high electrical conductivity at relatively shallow depths beneath the Andes of Southern Peru. The Biophysics group of this Department using the DNA-agar column technique has shown that the DNA of a specialized cell is identical with that of a germ cell and has the whole genetic message, but the messenger RNA that determines the protein content of the specialized cell is not a one-to-one matched copy of the DNA message (nucleotide sequences). Parts of the genetic message have been suppressed and other parts greatly intensified or repeated in the RNA, resulting therefore in the synthesis of highly specialized proteins (and enzyme functions) for each of the specialized cells.

Plant Biology Department's major programme is a concentrated effort to understand the mechanism of photosynthesis. The concerned groups continued their researches on the two areas of investigation, namely, (*i*) the changes induced in the state of those substances, called "intermediates", which play an important role in photosynthetic processes, and (*ii*) the changes in the rates of oxygen evolution or uptake caused by light exposures differing in colour, intensity, and time.

In the Department of Embryology the year was marked by the successful isolation and characterization of DNA from the eggs of *Rana pipiens* and *Xenopus lœvis*. The eggs of these species contain, in addition to a large pool of soluble deoxyribose compounds, an amount of DNA 100-300 times greater than is found in somatic cells of the same species. The material was characterized as DNA of high molecular weight, resembling liver DNA of the same species.

The Genetic Research Unit reports results of further progress during the year in the two main areas of research, namely, (*i*) the study of the control system regulating the somatic expression of the genes, and (*ii*) the study of the relation between DNA structure and chromosomal function.

LETTERS TO THE EDITOR

SOME ASPECTS OF SEVERE COLD WAVES IN INDIA

NOVEMBER TO MARCH is the cold weather period in India. During this period winds in the lower levels of the atmosphere are normally from the colder regions situated to the north of India. Being of continental origin these winds are relatively dry. Occasionally they bring unusually cold air mass to India and cause cold spells with minimum temperature several degrees below normal. Such cold spells can migrate from one area to the other. Due to this they are called 'Cold Waves'.

An examination of the past records extending over a period of half a century has revealed that cold waves of the type mentioned above occur in the transition months of October and April also. Cold waves in January and February when the normal minimum temperature is sufficiently low may give rise to the phenomenon of frost which is very disastrous to crops. In all the months October to April, a cold wave is certainly not a welcome phenomenon considering the large drop in temperature and moisture of air it brings about abruptly.

In this paper are briefly discussed, based on observations for the period 1911 to 1961, the broad features of cold waves that are considered to be severe with a drop (departure) in night minimum temperature of the order of 8° C. or more below its daily normal. Particulars of severe cold waves are given in Table I. Hill stations are not considered in this study except those of Jammu-Kashmir.

FREQUENCY OF SEVERE COLD WAVES

The incidence of severe cold waves is maximum in Jammu-Kashmir. On the average 4 severe waves occur in a year in this region. Towards the east and south of this region, their frequency in general decreases. Assam (excluding NEFA) experiences one wave in about 50 years and Rayalaseema one wave in 15 years on the average. Severe cold waves have not so far occurred in Interior Mysore (South) and the following coastal regions south of about lat. 20° N : Konkan, Coastal Mysore, Kerala, Madras State and Coastal Andhra Pradesh. The islands in the Arabian Sea and Bay of Bengal have also been free from severe cold waves.

For the country as a whole February can be considered as the month of maximum incidence of severe cold waves. Jammu-Kashmir is the only region where severe cold waves occur every year. Even here they do not occur in the same month every year. The available statistics do not suggest any periodicity in the incidence of severe cold waves in any region or in the country as a whole.

PERSISTENCY OF SEVERE COLD WAVES

In Jammu-Kashmir severe cold waves last for a period of 4 to 5 days except in April when they last for a day on the average. In Rajasthan, Saurashtra-Kutch and Madhya Pradesh (West) they persist for 2 to 3 days particularly in the month of January. Elsewhere they persist for a day or two. Maximum duration of severe cold waves so far observed in each subdivision is given in Table I.

If we follow the course of each cold wave from one part of India to the other, then it is seen that severe cold waves usually have a life span of about 4 to 5 days in the plains of India.

INTENSITY OF SEVERE COLD WAVES

Intensity of severe cold waves is judged from the departure of minimum temperature from the normal. Except in Jammu-Kashmir, Uttar Pradesh (West), Rajasthan (West), Madhya Pradesh (West) and Saurashtra-Kutch, their intensity elsewhere in the country is of the order of 8 to 9° C. below normal.

In Jammu-Kashmir cold waves are usually very intense with minimum temperature dropping 10 to 12° C. below normal. 9 to 10° C. is the usual departure of minimum temperature in association with severe cold waves in Uttar Pradesh (West), Rajasthan (West), Madhya Pradesh (West) and Saurashtra-Kutch during the months January to March. In the other months, their intensity is less than 10° C.

Table I shows that the severest cold wave on record in the country had a departure of 19·7° C. (at Dras on the 23 March 1911). This wave, however, was confined to a small area in Ladakh. In the plains of India the severest cold wave of appreciable extent was perhaps that prevailed from 30 January to 2 February 1929. Its intensity was maximum on 1 February when minimum temperature dropped by 12° C. below normal over a considerable area in Madhya Pradesh (West) and its adjoining parts of Saurashtra-Kutch, Gujarat and Madhya Maharashtra. The minimum temperature and

its departure from normal on 1 February 1929 are given in Fig. 1.
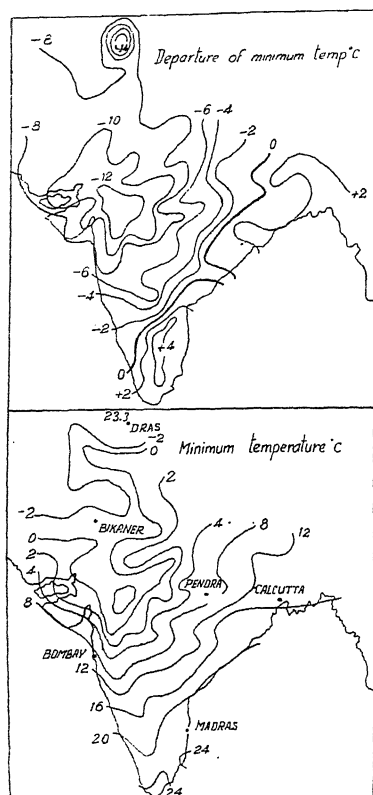
FIG. 1. Severest cold wave in the plains of India on 1st February 1929.

LOWEST MINIMUM TEMPERATURE

Over regions susceptible to severe cold waves, the lowest minimum temperature is generally caused by these waves. Very often, particularly for engineering and industrial design purposes, information on the lowest minimum temperature actually experienced over a region is also required. In Fig. 2 are therefore given the iso-therms of the lowest minimum temperature ever recorded in India (including the regions free from severe cold waves) during the years 1881 to 1964. This shows that 0° C. isotherm passes through Saurashtra-Kutch, Gujarat, Madhya Maharashtra, Madhya Pradesh and Bihar. The lowest temperature (− 45·0° C.) in the country was recorded in Ladakh (at Dras on 28 December 1910). In the plains of India, Rajasthan (West) has on record the lowest minimum temperature of − 4·4° C. (at Jaisalmer on 4 January 1949).

TABLE I

Particulars of severe cold waves in India during the years 1911 to 1961

Subdivisions		Total No.	Maximum intensity (departure ° C.)	Maximum duration (No. of days)
Konkan	..	0	..	..
Coastal Mysore	..	0	..	..
Interior Mysore South	..	0	..	..
Kerala	..	0	..	..
Madras State	..	0	..	..
Coastal Andhra Pradesh	..	0	..	..
Assam (excluding NEFA)	..	1	8·3	2
Rayalaseema	..	3	8·3	1
Marathwada	..	4	10·1	2
Telangana	..	5	8·9	2
Orissa	..	5	9·5	4
Uttar Pradesh East	..	8	8·4	1
Interior Mysore North	..	10	9·0	1
Bihar Plains	..	11	10·8	4
West Bengal	..	13	10·0	2
Bihar Plateau	..	14	11·0	5
Madhya Pradesh East	..	21	10·5	8
Vidarbha	..	24	10·5	3
Punjab	..	28	10·5	6
Madhya Maharashtra	..	29	12·2	5
Gujarat	..	31	12·8	4
Uttar Pradesh West	..	38	11·1	7
Saurashtra-Kutch	..	45	12·2	6
Rajasthan East	..	52	11·3	8
Rajasthan West	..	56	13·7	7
Madhya Pradesh West	..	61	12·8	8
Jammu-Kashmir*	..	183	19·7	30

* Based on data 1911 to 1950.
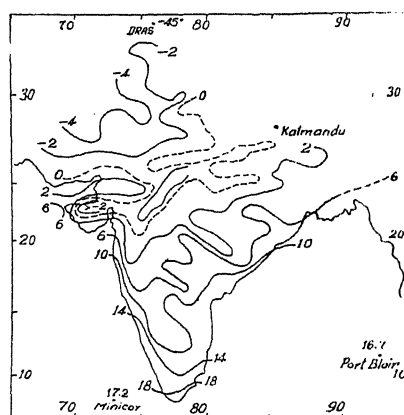
FIG. 2. Lowest minimum temperature ° C. ever recorded in India during the years 1881 to 1964.

LOCAL VARIATIONS OF SEVERE COLD WAVES

An examination of Table I shows that during the years 1911 to 1961 Saurashtra-Kutch and Madhya Pradesh (West) experienced more number of severe cold waves than Gujarat which is situated between these two regions. Compared to Jammu-Kashmir and Rajasthan, the number of

severe cold waves that affected Punjab was considerably small. Between Rajasthan (East) and Madhya Pradesh (West) also similar variation in the incidence of severe cold waves exists. These variations seem to be responsibe for the large distortions in the isotherms of the lowest minimum temperature given in Fig. 2. The factors responsible for the anomalous distribution of the frequency of severe cold waves are under study and its results will be published eslewhere.

Meteorological Department,
Poona,   K. RAGHAVAN.
January 6, 1965.

CONDENSATION OF
o-PHENYLENEDIAMINE WITH ACETONYL ACETONE

a-DIKETONES on reaction with one mole of 1 : 2-diamines are known to yield pyrazine derivatives in very good yields.[1-3] Formation of benzodiazapine derivatives has been reported from the condensation of o-phenylenediamine with β-diketones.[4-6] Buu-Hoi and Xuong[7] reported the formation of 1, 1'-o-phenylene bis (2 : 5-dimethyl pyrrole) by refluxing o-phenylenediamine with two moles of acetonyl acetone for 24 hours in the absence of solvent. In the present investigation a step-wise study of the reaction between o-phenylenediamine and acetonyl acetone has been undertaken as a representative case to understand the course of this reaction. Since acidic conditions favour the formation of cyclic products, acetic acid has been chosen as the solvent for the reaction.

The condensation when carried out in equimolecular proportion at room temperature resulted in a single crystalline compound. Formation of the same compound has been noticed in varying yields when the reaction was carried out in 1 : 2 as well as 2 : 1 proportions at room temperature indicating that the course of the reaction is not altered by changing the proportion of the reactants. The I.R. spectrum of the substance revealed the presence of a primary amino group (3600, 3700 cm.$^{-1}$) and the absence of the carbonyl function (no absorption between 1750 and 1680 cm.$^{-1}$). Formation of an acetyl derivative under mild conditions and of a phthalamic acid derivative at room temperature, further established the presence of a primary amino group. The absence of oxygen in the compound is evident from the carbon, hydrogen and nitrogen analysis. All these data led us to the view that the condensation involves one amino group of the diamine and two carbonyls of the γ-diketone, forming 1-(o-amino phenyl)-2 : 5-dimethyl pyrrole (I) according to the classical Knorr-Paal pyrrole synthesis.[8] Under identical conditions, aniline and acetonyl acetone have been found to react to give an excellent yield of 1-phenyl-2 : 5-dimethyl pyrrole, a compound known in literature.[9]

It is considered worthwhile to independently synthesise this compound by reduction of the corresponding o-nitrophenyl pyrrole derivative. 1-(o-Nitrophenyl)-2 : 5 dimethyl pyrrole (II) has been obtained as an yellow crystalline solid in modest yields by refluxing o-nitroaniline with acetonyl acetone in acetic acid for many hours. This compound has not so far been reported in literature. Earlier attempts made by Hazlewood *et al.*[9] to prepare this substance have been reported to be unsuccessful. Reduction of the o-nitrophenyl pyrrole derivative has successfully been accomplished by aqueous ferrous sulphate and iron powder and the product thus obtained has been found to be identical in melting point, crystalline shape and Infra-Red spectrum with the substance obtained from o-phenylenediamine reaction.

The condensation of the aminophenyl pyrrole (I) with another mole of acetonyl acetone by refluxing in acetic acid has yielded a crystalline product in good yields. The absence of an amino group in this compound is evident from insolubility in dilute acids and from I.R. spectrum (no absorption at 3600 and 3700 cm.$^{-1}$), the latter also revealing the absence of carbonyl function. Based on this data and analytical values, this compound has been assigned the structure 1, 1'-o-phenylene bis (2, 5-dimethylpyrrole) (III), identical with the compound reported earlier by Buu-Hoi and Xuong.[7]
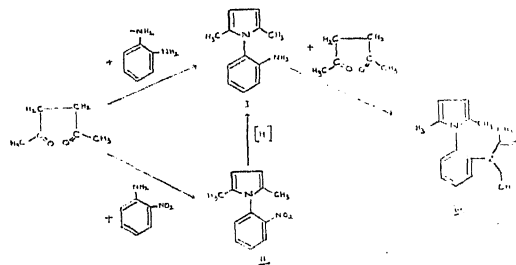
It therefore appears that while o-phenylenediamine is a versatile intermediate for many kinds of diaza heterocycles, in condensation with γ-diketones, however, it merely serves the function of a monoprimary amine in Knorr-Paal pyrrole synthesis. Further work on the conden-

sation of substituted diamines with di-ketones leading to the formation of heterocyclic ring systems is in progress.

One of the authors (K. S. R.) is grateful to the C.S.I.R. for the award of a Junior Research Fellowship.

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Osmania University,   K. SUDARSANA RAO.
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A KINETIC INVESTIGATION OF THE REACTION BETWEEN DIMETHYL-SULPHONIUM METHYLIDE AND BENZALDEHYDES

WE wish to report the results of a kinetic investigation of the reaction between the ylid, dimethylsulphonium methylide, generated *in vivo*, and a few benzaldehydes. This is the first report of its kind in the chemistry of sulphur ylids.

Dimethylsulphonium methylide has been employed as a reagent for selective oxirane synthesis from aldehydes and ketones by Corey *et al.*[1]

In our investigations, the ylid was generated by the action of alkoxide bases on trimethyl-sulphonium iodide in DMSO-alcohol media[2] and reacted with the benzaldehyde present in the same medium. The rate of consumption of the various benzaldehydes was followed gravimetrically by the precipitation of the unconsumed aldehyde as the 2 : 4 dinitrophenylhydrazone derivative.[3]

As the solubility of the alkoxides (sodium methoxide and potassium t. butoxide have been used) was found to be too low for our purposes, the alkoxides were dissolved in the appropriate alcohol and added to the DMSO solution containing the sulphonium iodide and the aldehyde to initiate the reaction.

In one case, the rate of alkoxide consumption was also followed by quenching the aliquot in a known quantity of hydrochloric acid and back-titrating the excess acid with standard potassium hydroxide solution using neutral-red-methylene blue as a 'screened' indicator,

In a run using *ca.* 0·06 M trimethylsulphonium iodide, *ca.* 0·06 M benzaldehyde and *ca.* 0·08 M potassium t. butoxide in 25% DMSO—75% t. butanol (v/v) as reaction medium, no appreciable change in the benzaldehyde concentration could be detected even after 20 hours. Similarly with sodium methoxide in 50% DMSO—50% methanol no change in benzaldehyde concentration was observable up to 12 hours. Runs with 80% and 90% DMSO (v/v) content in the solvent medium showed that the aldehydes were consumed with increasing rates.

The reaction on the whole proceeds possibly in three steps : (1) generation of the ylid by abstraction of a proton from the sulphonium compound by the alkoxide base, (2) collapse of the ylid to generate a carbene, which (3) adds on to the carbonyl bond of the aldehyde to give oxirane :

$$\text{I. } (CH_3)_2 \overset{+}{S} - CH_3 + CH_3O^- \xrightarrow[CH_3OH]{DMSO}$$
$$(CH_3)_2 \overset{+}{S} - \overset{-}{C}H_2 + CH_3OH$$

$$\text{II. } (CH_3)_2 S - \overset{..}{C}H_2 \longrightarrow (CH_3)_2 S + :CH_2 \text{ (singlet)}$$

$$\text{III. } :CH_2 + ArCH = O \longrightarrow \underset{\underset{CH_2}{|}}{Ar - CH - O}$$
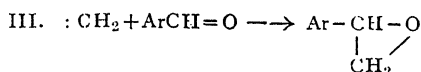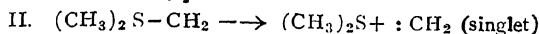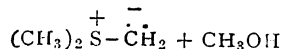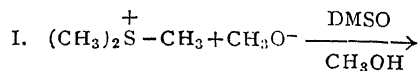
Presumably the steps I and III are rate determining. A third possibility that only step II might be rate-controlling for the overall reaction was ruled out on the basis that the change in aldehyde concentration in all experiments done does not obey unimolecular (first order) kinetic equations.

The drift observed in the calculated rate-coefficients possibly indicate a complex type of kinetics, with more than one step being involved in determining the overall rate of the reaction. That the first step, *viz.*, proton abstraction to generate the ylid is one of the rate-determining steps under above conditions, *viz.*, in 80% and 90% DMSO, seems to be certain. Thus the titrimetric method of following the alkoxide consumption shows that the rate constant for this step in 90% DMSO is of the order of 0·35 l.m.$^{-1}$ sec.$^{-1}$ In 80% DMSO the overall reaction is much slower and in 50% DMSO as indicated above, no reaction could be detected even after 12 hours. Thus the rate of generation of the ylid, and hence of the whole reaction, seems to be greatly accelerated by increasing the DMSO content of the medium. This observation is in conformity with similar results obtained by Cram *et al.*,[4] who attributed the increased

basicity of alkoxide ions with increasing DMSO content of the solvent medium to the poor solvation of the alkoxide anion by DMSO making it highly reactive. In methanol the reduced reactivity of the base is attributed to its 'buffering' by methanol due to the presence of solvent-anion hydrogen bonds $(CH_3OH....OCH_3)$. With 90% DMSO as the medium, as the ylid is generated much faster, a constant should result for the overall reaction if the last step were much slower and hence rate-determining. But the fact that only a drift in the calculated coefficients is observed indicates that even under these conditions, more than one step is involved in determination of the rate of overall reaction.

We acknowledge our gratitude to Prof. S. V. Anantakrishnan, Chairman, Department of Chemistry of this College, for his helpful suggestions. One of us (P. S. R.) thanks the National Institute of Sciences of India for the award of a Senior Research Fellowship.

Dept. of Chemistry,   R. SIVARAMAKRISHNAN.
Madras Christian   P. S. RADHAKRISHNAMURTI.
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USE OF ISOPROPANOL IN THE ESTIMATION OF FREE FATTY ACIDS

FREE fatty acid content of edible oils and fats and fats in foods is a direct measure of hydrolytic rancidity on storage. Usually it is expressed as percentage of oleic acid for most of the edible fats and oils, the threshold value being 1·5%.[1] The quantitative estimation of the free fatty acid is commonly done by acidimetric methods employing neutralised ethanol either alone or in combination with benzene or ether.[1-7] The above methods employ normally titrations, while hot, to ensure maximum extraction of the free acid from the fat.

During the course of storage trials on various fresh and processed rations of Defence interest, isopropanol was used as the solvent instead of ethanol in the estimation of the free fatty acid. The method in brief consists of extraction of the free fatty acid in the cold from the fat by using neutralised isopropanol (20–30 ml.) and titrating against standardised aqueous or alco-

holic alkali, using phenolphthalein as indicator, in the cold. Free fatty acid is calculated as percentage oleic acid. The modified method has been successfully applied in the estimation of free fatty acids of common edible oils and fats. Results are presented in Table I in comparsion with the standard method.[6] The new method is as good as the standard method, giving reproducible results, even in the cold. Moreover isopropanol is freely miscible with water, which is advantageous while titrating with aqueous alkali.

TABLE I

Free fatty acid content of common edible oils and fats by the new method

Edible oil/fat	Free fatty acid (% oleic acid)		Remarks
	New method	Standard method[6]	
Sesame oil ..	1·98, 2·02	1·91, 1·93	..
Mustard oil	0·84, 0·85	0·81, 0·79	..
Groundnut oil	0·35, 0·33	0·37, 0·36	..
Coconut oil*	1·85, 1·71	2·01, 2·12	*Lauric acid(%)
Lard ..	0·73, 0·75	0·78, 0·77	.
Ghee ..	0·82, 0·81	0·83, 0·84	Solid fats are melted before the estimation of FFA
Butter ..	0·29, 0·33	0·29, 0·33	..
Vanaspathi ..	0·13, 0·14	0·16, 0·17	..

Standard deviations of the new method (0·010) compared to that of the standard method (0·035) are negligible. Recovery of oleic acid is 97·79% to 99·65% for the range 0·5 g. to 2·5 g. in the new method using isopropanol.

Defence Food   S. RAMANUJAM.
   Research Lab.,   K. VIDYASAGAR.
       and
Defence Research and   T. M. ASWATHNARAYANA.
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CHEMICAL EXAMINATION OF *VISCUM ARTICULATUM*

Viscum articulatum (N.O. Lorantaceæ) is a hemiparasitic plant generally growing over *Diospyros* and *Brassica* spp. in subtropical and temperate regions. It has been used as an aphrodisiac and in fever.[1] Oleanolic acid, beta-amyrin and other triterpenoids have been isolated from *V. album*[2] and its subspecies.[3] Isolation of oleanolic acid, ceryl oleanolate and mesoinositol is reported in the present communication, from the title plant. Ceryloleanolate has not been reported to occur in nature so far.

Viscum articulatum growing on *Diospyros melanoxylon* (collected in December, 1963 from Bithli, Distt. Balaghat, M.P.) was sun-dried and extracted with hot benzene. The concentrated extract was shaken with 1 : 1 aqueous ethanolic sodium hydroxide (10%). The separated alkali layer on acidification and re-extraction with benzene yielded a solid A, and the benzene layer on evaporation yielded a viscous oil B.

The solid A purified through the preparation of its sodium salt, after several recrystallisations (yield 0·6%), had m.p. 304–7°, and gave yellow colour with tetranitromethane and answered colour reactions characteristic of triterpenes; acetate m.p. 267–68°, benzoate 261–63°, methyl ester 197–99°. Its identity as oleanolic acid was confirmed by mixed m.p. (undepressed) with an authentic sample of methyl oleanolate.

The oil B neither could be crystallised after repeated chromatography over alumina, nor did it give crystalline acetate or benzoate ; it gave yellow colour with tetranitromethane ; orange → red with conc. sulphuric acid ; orange → pink → purple (Lieberman Burchard) pink → purple → deep red (Nollér's reagent); red colour with trichloroacetic acid, and positive hydroxamate test on prolonged treatment with hydroxylamine. On saponification with alcoholic potassium hydroxide (10%) for 30 hours it gave a solid, m.p. 300–8° (8% yield). These suggested that B contained an ester of triterpenic acid, presumably oleanolic acid.

The oil (800 mg.) in tetrahydrofuran (10 ml.) was added to a slurry of lithium aluminium hydride (400 mg.) in ether, mixture kept for 16 hours and processed. The product when chromatographed over alumina, gave two compounds C and D. Compound C : m.p. 235–37°, $(\alpha)_D^{25} + 76°$ (chloroform), diacetate, m.p. 184–85°, $(\alpha)_D^{26} + 59°$ (chloroform). It was identified as the erythro-diol obtained by reduction of oleanolic acid.[4]

Compound D : was identified as ceryl alcohol, m.p. 79–80°, d_4^{85} 0·8215. On oxidation with potassium permanganate it gave an acid, m.p. 85°, anilide m.p. 87° (Found N : 3·06, $C_{32}H_{57}ON$ requires N, 2·98%).

The ethanol extract of the exhausted plant material gave a solid, m.p. 225–26°, hexaacetate, m.p. 212–13°, R 0·13 (acetone : water 95 : 5), which was identified as mesoinositol.[5]

The author wishes to thank Dr. A. K. Barua, Bose Institute, Calcutta, for an authentic sample of methyl oleanolate.

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IDENTIFICATION OF THE LANGERHANS' CELL FROM THE MELANOCYTE IN HUMAN SKIN

Birbeck *et al.*[1] reported that it is difficult to distinguish the Langerhans' cell from the melanocyte in sections of human skin. This may be due to the fact that in sections of human skin, the dendritic processes, which are characteristic for each type of cell, lie hidden in the intercellular spaces.[2] This difficulty is obviated when they are visualised in isolated cell preparations made according to the technique of Shukla, Karkun and Mukerji.[3]

Figures 1 and 2 respectively show a melanocyte and a Langerhans' cell prepared from the normally pigmented human skin from the peroneal surface of the human leg. The morphology of the melanocyte isolated from the skin of guinea-pig and human beings has been amply described by Shukla, Karkun and Mukerji[4] and Shukla and Mukerji (*loc. cit.*) respectively. A description of the isolated Langerhans' cell has not been made so far and is reported below :

The Langerhans' cell, for the purpose of description, may be divided into the body proper and the dendritic process (Fig. 2). The body is thin and flat and is triangular or oval in shape. It measures 8–10 μ at the long and 4–6 μ at the short diameter. The upper and lower surfaces of the body are straight and flat in

contrast to the concave upper surface of the melanocyte in human beings. The dendritic processes in the Langerhans' cell arise either from the apices of the triangular or from the

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FIGS. 1–2. Fig. 1 shows an isolated human melanocyte with a polygonal body (*b*) and dichotomously branched and bulb-tipped dendritic processes (*d.p.*). Fig. 2 shows an isolated Langerhans' cell with a fusiform body (*b₁*) and unbranched and fine-tipped dendritic processes (*d.p.₁*).

two ends of the oval body. The number of the dendritic processes in Langerhans' cell is restricted to two, three or four. The melanocyte (Fig. 1), on the other hand, possesses four to six dendritic processes arising from the ends and sides of the body. The length of the dendritic process in both the types of cell is 15–20 μ but in the melanocyte it is more prominent and measures 2–3 μ at the root and ends in the form of a bulb of nearly 2 μ in diameter. In contrast, the dendritic process of the Langerhans' cell is thin and slender. It measures about 1 μ at the root and ends in a fine thread-like structure. It does not branch except near the tip, whereas in the melanocyte it starts branching in a dichotomous fashion from the very origin. Therefore, although the overall size of both the cells is approximately the same, yet they can be identified by the size and the shape of the body and the nature of the dendritic processes.

Thanks are due to Mr. R. K. Saraut for technical assistance.

Central Drug Research   R. C. Shukla.
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Chattra Manzil Palace,
Lucknow, *February* 27, 1965.

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RIPPLE-MARKS IN THE CHAMPANER ARAVALLI QUARTZITE OF PANCH MAHALS DISTRICT, GUJARAT

THE author records here for the first time the ripple-marks which he had observed in the Precambrian quartzite of Panch Mahals district, Gujarat, in the course of recent geological survey of the area. The previous workers,[1-6] who made investigations in Panch Mahals and Baroda districts had not recorded ripple-marks in the quartzite of the area.

The quartzite belongs to the schistose rock series of south-eastern Gujarat, designated by Blanford[1] as the Champaner series. Later on, based on Heron's[7] work, Fermor[8] considered the series to be continuous with the Aravallis of Rajasthan. Pascoe[9] recorded it as the Champaner Aravallis of Gujarat. The outcrops of the quartzite have been traced continuously from Bhamria (22° 24' : 73° 34'), passing through Kathkua (22° 23' : 73° 39'), Richhbar (22° 23' : 73° 36') and other places to Sarsua (22° 24' : 73° 44'), beyond which they continue eastward up to Vishengarh (22° 28' : 73° 24').

The quartzite is steeply folded, the fold axes striking more or less WNW-ESE and pitching 35°–40° westwards. The rock is massive and thick-bedded, and generally recognised by its

pink colour and vitreous appearance. Some lithological variations were, however, noticed in the strike as well as dip directions. Near the base, the rock becomes appreciably gritty with the appearance of pebbles of the size of a walnut. At Bhat (22° 25′ : 73° 38′) and Bamankua (22° 27′ : 73° 37′) its composition becomes highly felspathic.

Some good exposures of ripple-marks in the quartzite have been recorded from Richhbar, Jaban, Sarsua and Poili, a small hamlet about 2 miles north of Kuivav. In some of these localities the quartzite was also found to be cross-bedded. The ripple-marks are well preserved at Richhbar, where they occur on the southern slope of an outcrop of quartzite forming an anticlinal ridge (Fig. 1) and also along

FIG. 1. An outcrop of quartzite showing well-preserved ripple-marks.
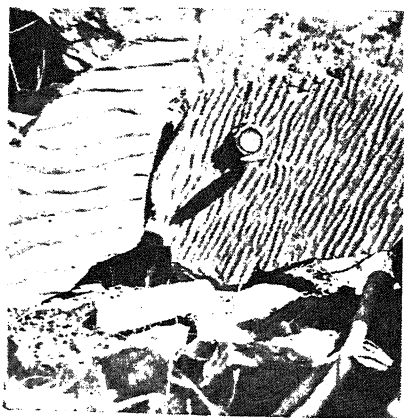
FIG. 2. Oscillation ripples (left) and current ripples (right), shown in two different hand specimens of quartzite.

an arcuate ridge of quartzite facing Poili on the north. At Jaban and Sarsua they are quite distinct but not so well preserved owing to weathering.

The ripple-marks are distinctly of two varieties, viz., current and oscillation ripples (Fig. 2), which differ greatly in their shape, size, amplitude, etc. The current ripples are asymmetrical and occasionally interfering. The ratio of their amplitude to wavelength ranges between 1 : 4·5 and 1 : 7. These ripples may, therefore, be regarded as formed by water currents (Kindle and Bucher[10]). The oscillation ripples, being symmetrical and non-interfering, have broad and rounded crests, and narrow troughs. These ripples are strikingly similar to those described by Dunbar and Rodgers,[11] who considered that such oscillation ripples were probably formed also "under standing water shallow enough for oscillation waves to reach the bottom".

These current and oscillation ripples in the Champaner Aravalli quartzite of Panch Mahals may be taken as establishing the shallow-water origin of the rock.

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LEECHES AS ENDOPARASITES IN CENTIPEDES

LEECHES are mostly predators and a few are ectoparasites ; in most cases, such ectoparasitism is usually temporary, the leech abandoning its host when it is gorged with blood or lymph.[1] In a recent communication Mann and Tyler[2] have reported, for the first time, that leeches of the species *Philaemon grandidieri* are found as regular endoparasites in the lymph space beneath the skin of several species of frogs. The present communication reports another instance of endoparasitism where leeches of the genus *Herpodella* occur in the gut of centipedes *Scolopendra morsitans* and *S. cingulata*.

These centipedes are found in Alagarkoil Hills (South India 9° 55′ N. latitude and 78° 10′ E. longitude), in wet mud below stones and logs which lay half submerged on the ground. Out of 25 of the centipedes examined in a single collection, 21 of them were found to be infected by these leeches. In one instance, a *S. morsitans*, 15 cm. long, was found to be infected by 34 of these leeches.

The largest of these leeches measured a little less than 5 mm. in length and about 0·5 mm. in width (Fig. 1), with well developed posterior
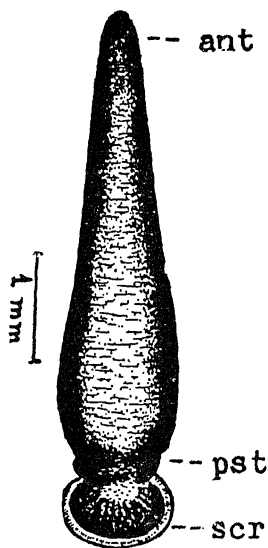
FIG. 1. Dorsal view of the endoparasitic leech *Herpodella* sp. (fully extended). *ant*, anterior end ; *pst*, posterior end ; *scr*, sucker.

sucker, with which they cling to the intestinal epithelium of the host (Fig. 2).

It is of interest to note that there appears to be periodicity in the infection of these leeches in relation to the condition of the environment and the mode of life of their hosts. In the rainy season (September to December) when the soil is very wet and the atmospheric temperature low, the centipedes have been noted to lead an active life, while in summer (January to August) when the soil is dry and the atmospheric temperature comparatively high, they bury in the soil and remain inactive in a state of suspended animation. The parasitic leeches appear to occur only in the centipedes collected in summer, while in those collected in the rainy season no parasitic leeches are found. In the rainy season the leeches belonging to the same species have been found free living attached to the lower surfaces of the half-

buried rocks and logs where the centipedes are commonly found. In summer such free-living leeches are not found.

FIG. 2. Photomicrograph showing an endoparasitic leech (*Herpodella* sp.) attached to the intestinal epithelium of the centipede, *Scolopendra morsitans*. 1. Intestinal epithelium of the centipede ; 2. The parasite.

Examination of centipedes collected in the month of January showed small-sized, probably juvenile forms, of these leeches attached to the spiracles of the centipedes. It is suggestive that the spiracles may be the pathways of entry for these leeches.

In the gut which is infected by the leeches, the smaller ones were found in the anterior region of the gut and larger forms confined to the posterior region. It is not known where the cocoons are laid, whether in the hind gut of the host or in the soil after the parasites have emerged out of the host.

Department of Zoology,   G. SUNDARA RAJULU.
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STUDIES ON THE PATHOLOGY OF *STEPHANOFILARIASIS ASSAMENSIS* IN CATTLE

THE pathology of "Humpsore" caused by *Stephanofilaria assamensis* has not been systematically studied. A detailed histopathological examination of several pieces from different stages of sore lesions was therefore carried out. The material was received from Gauhati, Calcutta and Bhubaneswar. The salient observations are briefly described below :

On histopathological examination of 'sore' lesions, four stages, *viz.*, infective, acute, desquamative and cicatrial, on the basis of the parasitising stages of worm and the associated pathological tissue changes, were earlier recognised (Sharma Deorani, 1963). The infective stage then described by the author is now considered to be 'sub-acute stage', since the large-sized microfilariæ present in the lesions are now recognised to be the 'mature microfilaria' (Buckley, 1937). The desquamative stage thus contained only 'immature microfilariæ' individually encysted. Though a large number of young worms were present in the acute stage no infective larvæ could be seen. The presence of mature microfilariæ in comparatively healthier portions of the skin was quite surprising, when compared to the nearly ulcerative lesions of the desquamative stage which it should follow.

Grossly also these lesions could be differentiated. The lesions of the sub-acute and acute stages looked somewhat similar, characterised by the surface almost devoid of hair, appeared granular and slightly raised ; the cut surface clearly showed epidermal proliferations resulting in shallow corrugations. The oozing of lymph formed crusts on the surface of the lesions. However, in acute stage the granulations and epidermal proliferation were much more intense and the cut surface showed deep and close corrugations, with thick keratinised tissue layer over it. The lesions of the desquamative and cicatrial stage appeared to be quite distinct. The lesion of the former stage had nongranular, moist and unevenly smooth surface, devoid of horny epidermis and absence of any epidermal proliferative changes in the cut surface. The later stage lesion could, however, be easily made out by the hardness and smoothness of the contracted scar tissue. These gross characteristics can help in knowing roughly the parasitising stage of the worm present in any site of the lesions, without the help of the microscope, and probably in making collections of the specific stages of the worm for morphological studies.

Attempts were further made to study as to why, even in the absence of reinfection by vectors, there was recurrence and reaggravation of the lesions in the following season. On the basis of our studies and those conducted by Pande (1935) and Varma (1956), the following feasible probability comes to light. In the sections examined by me there was usually absence of microfilariæ in the acute stage and similarly almost complete absence of the adult worms in the desquamative stage. Further, no dead or degenerating worms were detected in the sections of these stages. These facts, together with the description of quiescent lesions described by Pande, show that the adult worms, after discharge of large number of microfilariæ by the females, may not be dying at the site but instead may be migrating to the periphery, at least on the onset of the desquamative stage. Probably these worms in new sites may first remain dormant up to the following season, and later their reactivation in the ensuing season may be responsible for the recurrence of the fresh acute stage lesions.

Critically studying the related epidemiological description of Pande, one more thing is also clear that there can be only one generation of these worms during a year unlike two generations a year, believed in case of *S. zaheeri* (Singh, 1958) infection of which is popularly known as 'Ear Sore' of buffaloes in India (Ahmad, 1961). Further, it is also believed that in case of this infection, the larva may not migrate along the follicle towards the surface of the skin, as was thought by Levine and Morall (1955) in case of *S. stilesi*. Of course, presence of good number of very young worms usually in the epidermis and superficial dermis in the acute stage may somewhat suggest that the infective larva perhaps comes from exogenous source.

Division of   V. P. SHARMA DEORANI.
 Parasitology,
Indian Veterinary Research Institute,
Izatnagar, *February* 10, 1965.

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ELEUTHERANTHERA POIT.
A COMPOSITAE GENUS NEW TO
INDIAN FLORA

THE genus *Eleutheranthera* is represented by the only species *E. ruderalis* (Sw.) Sch. Bip. The author of this paper, who is making a study of the flora of Howrah Dt. (W. Bengal), collected the above species at Panchpara, which is about 3 km. towards South-East of the Indian Botanic Garden and situated near the bank of river Hooghly. This plant was found growing luxuriantly, in society in shady places during the rainy season in the month of June. In the field the plant closely resembles *Synedrella nodiflora* (L.) Gaertn., but differs in having stems slender and capitula drooping down in long peduncles.

E. *ruderalis* is an American weed and its possible introduction to the Indian soil may be through the American ships coming to the dock through the river Hooghly. Even though the plant is quite at home at the place where it was collected, now it has not spread considerably even by virtue of its family character. So this species can only be a recent introduction to India. The identification of this plant was confirmed at the Herbarium of the Royal Botanic Gardens, Kew.

Eleutheranthera ruderalis (Sw.) Sch. Bip. in *Bot. Zeit.*, 24 : 165, 1866. *Melampodium ruderale* Sw. *Fl. Ind. occ.*, 3: 1372, 1806.

Erect annual herb, 30–45 cm. tall; branches many, slender, scabrous. Leaves 1·4–5·8 × 1–3·4 cm. ovate or ovate-lanceolate, scabrous on both surfaces, crenulate or slightly undulate, acute to subobtuse at apex, trinerved and obtuse at base; petioles up to 1·5 cm. long. Capitula 4·5–6 mm. across, homogamous, solitary axillary; peduncles up to 2 cm. long, drooping down, involucral bracts 5–8 unequal, each 5–7 × 1·5–2·5 mm. oblong to oblong-ovate, obtuse, densely hispid without, sparsely hispid or glabrate within. Florets 6–9, bisexual, each floret subtended by a receptacular bract; receptcular bracts 4–4·5 mm. long, elliptic-oblong, apex acute or acuminate, margins hairy above the middle; corolla 2–2·5 mm. long, yellow, tubular, 5-toothed

at apex, outer surface of teeth minutely pubescent; stamens 5, anthers not syngenesious, sagittate at base; ovary linear oblong style-arms long, linear, minutely hairy; achens ± 2·5 mm. long, minutely puberulous towards
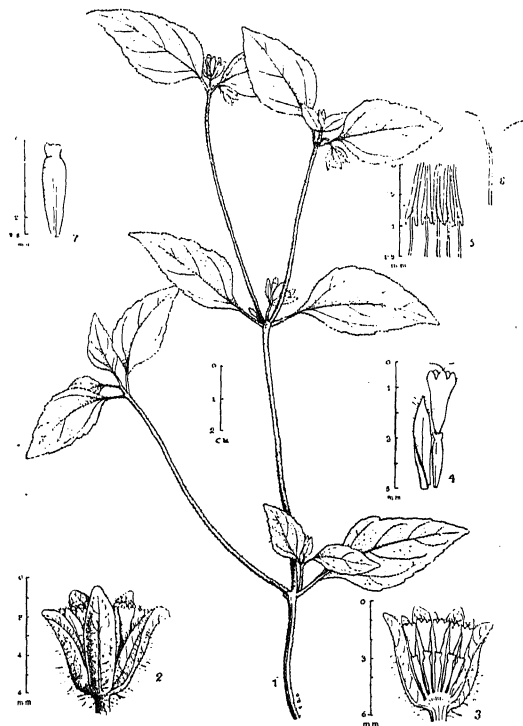
FIGS. 1–7. Fig. 1. Portion of the plant. Fig. 2. Capitulum. Fig. 3. L. S. of capitulum. Fig. 4. Flore. with receptacular bract. Fig. 5. Stamens. Fig. 6. Stylet Fig. 7. Achene.

the upper end, tip mounted with a puberulous cup. Specimens examined : *Bennet* 774 (CAL).

Grateful thanks are due to Dr. S. K. Mukherjee, Keeper, Central National Herbarium, for his valuable guidance and constant encouragement and to the Director, Royal Botanic Garden, Kew, for kindly confirming the identification of the species.

Central National   S. S. R. BENNET.
     Herbarium,
Calcutta, *January* 23, 1965.

CHEMICAL INDUCTION OF POLLEN
STERILITY IN GRAPES

IT is now known that the selective abortion of pollen can be artificially induced in a wide variety of plants, through various chemical treatments.[1] Attempts to induce pollen sterility have so far been made mainly in annual crop plants and data on the usefulness of such

methods in fruit trees are not available. In grape, the small size of the individual bud renders hand-emasculation tedious and time-consuming and large-scale hybridization work is therefore handicapped. Chemical induction of pollen sterility can effectively replace the tedium of hand-emasculation if a proper technique is standardised. Hence a study was taken up in grapes using three chemicals—maleic hydrazide (MH), tri-iodobenzoic acid (TIBA)

higher, *viz.*, MH (750 ppm) and TIBA (500 ppm). The differential response might be due to the fact that the latter variety possesses a thick tomentum on the leaves which would have reduced the extent of adherence of the solutions on the leaf surface.

The percentage fruit-set and reduction in seed-setting in treatments that gave complete pollen sterility in the three varieties are presented in Table I.

TABLE I

Fruit-set and seed-set in treatments that induced complete pollen sterility

	Variety	Control	MH		TIBA		FW-450 (0·30%)
			500 ppm	750 ppm	400 ppm	500 ppm	
Fruit-set (%)	*Bhokri* ..	51·9	37·3	26·5	17·1	15·5	15·3
	Hussaini ..	40·5	31·7	15·7	13·7	8·5	11·6
	Rosem-T-Lahore ..	36·3	..	24·8	..	15·8	14·6
Reduction in seed-set (%)	*Bhokri* ..	..	16·14	18·84	14·46	17·38	10·14
	Hussaini ..	..	8·53	23·17	21·95	23·17	21·95
	Rosem-T-Lahore ..	..	..	6·66	..	6·66	26·66

and sodium, 1, 2-dichloroisobutyrate (FW-450). The varieties used in the studies were *Bhokri*, *Hussaini* and *Rosem-T-Lahore* (all belonging to *Vitis vinifera* L.). Aqueous solutions of MH (250, 500, 750 ppm), TIBA (200, 300, 400, 500 ppm) and FW-450 (0·05, 0·10, 0·20 and 0·30%) were applied as foliar sprays in the month of March on shoots with panicles of different ages.

All the treatments caused various types of leaf abnormalities resulting from the injury due to the spraying of the chemicals. The degree of damage depended on the concentration of the chemicals used. In general, the injuries were the highest in TIBA-treated shoots. The extent of pollen sterility that could be induced was found to be dependent on (*i*) the stage of development of the panicle at which sprays were given, (*ii*) concentration of the chemical, (*iii*) number of applications and (*iv*) the variety used for the study. Chemicals were applied once and twice (second spray to follow 2 to 3 days after the first one). Two applications were found to be effective in the induction of complete pollen sterility. In *Bhokri* and *Hussaini*, two applications of MH (500 ppm), TIBA (400 ppm) and FW-450 (0·30%) at an early stage of the development of the panicle (about 15 days after emergence) induced complete pollen sterility, whereas, in *Rosem-T-Lahore*, the effective concentrations were

It is evident that MH 500 ppm which induced complete pollen sterility in the varieties *Bhokri* and *Hussaini* gave the least reduction in fruit and seed-set. But in the variety, *Rosem-T-Lahore*, MH 750 ppm was the effective dose. The reduction of fruit and seed-set observed in these MH treatments are practically negligible considering the total number of fruits that could be obtained by hand pollination on the treated panicles. In all the treatments the germination of the seeds obtained was normal. Hence this method can be used with profit in large-scale grape hybridization. Using such a technique the authors could initiate a study on the degree of manifestation of metaxenia in grapes and also undertake large-scale hybridization in grapes.

Division of Horticulture,　　　C. P. A. IYER.
Indian Agricultural　　　　　　G. S. RANDHAWA.
　　Research Institute,
New Delhi-12, *February* 15, 1965.

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REVIEWS AND NOTICES OF BOOKS

Advances in Geophysics (Vol. 10). Edited by H. E. Landsberg and J. Van Mieghem. (Academic Press, New York and London), 1964. Pp. xi + 488. Price $ 16.50.

Volume 10 of this well-known series contains the undermentioned five articles : 1. Atlantic Air-Sea Interaction, by J. Bjerknes ; 2. The Optical Spectrum of Lightning, by Leon E. Salanave ; 3. Scattered Radiation in the Atmosphere and the Natural Aerosol, by Kurt Bullrich ; 4. Tensor Calculus in Atmospheric Mechanics, by Pierre Defrise and 5. Advances in Radar Meteorology, by David Atlas.

The following relevant remarks made in the foreword may be reproduced here : "It has been our conviction that comprehensive and critical reviews are the most potent answer to the so-called information crisis. The well-informed expert is best equipped to sort things out and place them in the proper perspective.' C. V. R.

Guide to Gas Chromatography Literature. By Austin V. Signeur. (Plenum Press, New York), 1964. Pp. 351. Price $ 12.50.

The volume consists of 7,500 references to the published literature and to papers presented at scientific meeting in the field of gas chromatography up to the end of 1963. This is the largest and most comprehensive work of its type ever published. The active as well as the potential worker in the field will be interested in the publication which will help him in acquiring a background knowledge of the technique and become acquainted with the theory, methodology, applications, and the versatility of gas chromatography. Wherever possible, reference is given to Chemical Abstracts so that the worker may obtain further information. C. V. R.

Methods of Silicate Analysis. Edited by H. Bennett and W. G. Hawley. (Academic Press, New York and London), 1965. Pp. xv + 334. Price 63 *sh*. 0 *d*.

This second edition of *Methods of Silicate Analysis* replaces that of 1958 which has already become out of date. It introduces new standard methods of analysis which are both faster and more accurate than those described previously.

More detail is included to give the book a wider scope with additional text matter gained as a result of current research and past experience. The new, and extremely fast, spectrophotometric methods suitable for large-scale analysis of silicates at the routine-control level are described, as well as more specialized techniques which may be applied supplementary to, or in place of, classical methods. For students and new staff in laboratories there is a separate section devoted to explanations of the chemical principles involved in these techniques with points on practically important details ; an extension of this part includes information about equipment and apparatus suitable for use in the smaller laboratory. C. V. R.

Group Theory and Solid State Physics : I. Edited by P. H. Meijer. (International Science Review Series.) (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. x + 293. Price $ 5.95.

This volume contains a selection of papers that have contributed to the understanding of the role of group theory in physics. In all, there are sixteen articles amongst which may be particularly mentioned the classical paper by L. Tisza, entitled "The Interpretation of the Spectra of Poly-atomic Molecules", published in 1932 and another paper by E. Winger entitled "Elastic Eigenvibrations of Symmetric Systems", published in 1930.

Group Theoretical Concepts and Methods in Elementary Particle Physics. Edited by F. Gursey. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. vii + 425. Price : Regular edition $ 19.50 ; Professional edition $ 12.50.

This volume contains the lectures delivered at the Istanbul Summer School of Theoretical Physics, from July 16 to August 4, 1962.

In all, there are thirteen articles in this book, their authors being G. Racah, E. P. Wigner, N. Burgoyne, O. W. Greenberg, Louis Michel, D. Speiser, S. L. Glashow, Y. Nambu, Abdus Salam, Feza Gürsey, E. Inönü, G. F. Dell'Antonio, O. W. Greenberg and E. C. G. Sudarshan and E. R. Caianiello respectively. C. V. R.

Interpretation of Metallographic Structures. By Willian Rostoker and James R. Dvorak. (Academic Press, New York and London), 1964. Pp. viii + 226. Price $ 10.00.

Viewed in an optical reflection microscope, metals and other opaque solids reveal structural details which relate to process origin and to physical and mechanical properties. By interweaving discussion of modern physical metallurgy with a large number of carefully selected exemplary microstructures, an interpretive framework may be defined through which metallography becomes a diagnostic tool rather than simply a means of identification. This book, intended for both advanced students and practising metallurgists as an adjunct to formal training and continuing experience, will be a useful reference for materials engineers and ceramists.   C. V. R.

Psychopharmacological Agents, Vol. 1. Edited by Maxwell Gordon. (Academic Press, New York and London), 1964. Pp. xvi + 678. Price $ 23.50.

This monograph satisfies the need for a review on psychopharmacological agents. Although written primarily for medicinal chemists and pharmacologists, the multi-disciplinary approach makes the book of interest to researchers in clinical investigation, biochemistry and organic chemistry. The subject-matter in this volume may be described thus: major classes of psychopharmacological agents are treated in separate chapters; each chapter covers history, synthesis, pharmacological activity, *in vivo* distribution and metabolic fate, analytical methods, and clinical uses of each class of psychopharmacological agents. The chapters are written by contributors to the discovery or development of each class.   C. V. R.

The Origins of Prebiological Systems and of Their Molecular Matrices. Edited by Sidney W. Fox. (Academic Press, New York and London), 1964. Pp. xx + 482. Price $ 8.00.

This volume is composed of contributions by leading theorists and experimenters in the study of the origin of life and the steps leading to the first life. It presents reviews of relevant earlier findings and of recent discoveries including theoretical treatments, reviews of experimental studies of models of prebiological systems, and reports of new results in models of biochemical origins. The book is divided into sections dealing with small molecules, macromolecules, and multimacromolecular systems.   C. V. R.

Analysis Instrumentation. Edited by L. Fowler, R. J. Harmon and D. K. Roe. (Plenum Press, New York), 1964. Pp. x + 340. Price $ 14.50.

This volume is the Proceedings of the Tenth National ISA Analysis Instrumentation Symposium held under the auspices of the Instrument Society of America in early June 1964, at San Francisco. It covers the latest developments in process and laboratory instrumentation and methods of chemical composition analysis, as well as specific new developments and reviews in various subdivisions such as chemical, electrochemical, physical, optical, radiation methods, gas chromatography, air pollution, and computer coupled applications. The coverage includes such currently important subjects as particle detection for air pollution analysis, atomic absorption spectroscopy, hydrogen analyzers, dissolved oxygen detection, and computer operation with analyzers.   C. V. R.

Interpreted Infra-red Spectra, Vol. 1. By Herman A. Szymanski. (Plenum Press, New York), 1964. Pp. 293. Price $ 10.75.

The aim and scope of this new series is primarily to help the reader learn to interpret infra-red spectra and identify compounds from them. Eventually, all common groups of compounds will be covered. This first volume includes those groups of compounds which exhibit the most widely encountered group frequencies, *viz.*, benzene derivatives, alkanes, alkenes, cyclopropanes, cyclobutanes, cyclopentanes and cyclohexanes.

The volume consists of a series of infra-red spectral recordings, with all significant bands identified so that they may be clearly recognized as they occur time and again in the spectra of related compounds. This method is of wider application than correlation tables, because in this presentation interfering bands and other related bands can be seen at a glance.   C. V. R.

Crystal Chemistry of Tetrahedral Structures. By Erwin Parthe. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1965. Pp. xii + 176. Price $ 9.50.

The characteristic features of tetrahedral structures are shown by analysis of the general principles responsible for a tetrahedral bond formation, covering briefly the sp^3 hybridiza-

tion and use of the Grimm-Sommerfeld rule and its extensions. Normal tetrahedral structures of elements, binary compounds, ternary and quaternary compounds are discussed, including a general treatment of homotect structure sets. Defect tetrahedral structures and the possibilities of forming filled tetrahedral structures are explained as well as composition diagrams for tetrahedral structures. Proposed theories relative to the subject are summarized, followed by two appendices discussed in detail : (1) the numerous notations for the stacking pattern of homotect SiC structures and (2) the space groups and point positions of the different tetrahedral crystal structure types, and giving a listing of the lattice parameters of all known tetrahedral structure compounds.

C. V. R.

Comparative Endocrinology, Vol. 1 : *Glandular Hormones*. Edited by U. S. von Euler and H. Heller. (Academic Press, New York and London), 1963. Pp. xii + 543.

Comparative Endocrinology, Vol. 2 : *Invertebrate Hormones—Tissue Hormones*. Edited by U. S. von Euler and H. Heller. (Academic Press, New York and London), 1963. Pp. xiii + 282.

This two-volume work provides a systematic and comprehensive account of the comparative aspects of endocrinology. It covers the similarities and differences discovered in the chemistry of the endocrine systems of the upper and lower vertebrates, and the resemblances in organization between vertebrates and invertebrates. Each section is written by an eminent scientist actively engaged in research on the subject covered, and provides a wealth of information on modern methods, recent progress, and present research.

The subject-matter has been divided into three sections. The largest—which forms the contents of the first volume—deals with hormones originating in well-defined glandular organs and tissues and also reviews the relationships between the central nervous system and these endocrine complexes. The second section (Volume II, Part 1) discusses hormonal systems or invertebrates, and the third (Volume II, Part 2) contains a description of neurohormones and tissue hormones. The well-documented and up-to-date picture of the subject presented in these volumes should be particularly welcome to the medical scientists and zoologists generally. They should also prove extremely useful to the

research worker who is beginning to take an interest in one of the many endocrine systems described.

C. V. R.

Advancing Frontiers in the Chemistry of Natural Products. [Hindustan Publishing Corporation, Delhi-6 (India)], 1965. Pp. xviii + 311. Price Rs. 35·00.

This volume which has been brought out to commemorate the sixty-fifth birthday of Prof. T. R. Seshadri appropriately begins with a short biographical sketch. It sets out his career as a Professor and leader of an active school of research at the Andhra University from 1938 onwards and at Delhi University since 1949. During the period of his association with these Universities, some ninety research students working under his guidance received their doctorate and numerous post-doctorate scholars and fellows have also been associated with him. Many of his past students now occupy professorial chairs at different Universities.

It is quite appropriate that the volume consists exclusively of contributions by Professor Seshadri's former students and collaborators. Nineteen authors have contributed to this volume which leads off with a paper by Sir Robert Robinson who was a Professor at Manchester and under whose guidance Dr. Seshadri worked when he received his doctor's degree in Chemistry in the year 1929.

The publication of this volume should be a matter of great satisfaction to all interested in the progress of research in India.

C. V. R.

International Review of General and Experimental Zoology (Vol. 1). Edited by William J. L. Felts and Richard J. Harrison. (Academic Press, New York and London), 1964. Pp. xi + 445. Price $ 14.50.

In a preface to the first volume of this new series, the editors explain the need for substantial reviews intended for the enlightenment of both general and specialist readers in the many classic and more recently expanding fields of zoology. Histochemistry, electron microscopy, and the application of physical methods to biological problems have widened the horizons of investigation. Animal behaviour, population, and genetic studies have greatly expanded. Comparative morphological, developmental, and anatomical studies are now frequently the basis of functional interpretation and experiment,

The present volume contains nine special articles on the undermentioned topics : 1. The Biology of Foraminifera ; 2. The Study of Longevity in Biting Insects ; 3. Equilibrium Orientation in Fish ; 4. Environment and Reproduction in Domesticated Species ; 5. The Evolution of the Long Flexor Muscles of the Leg and Foot ; 6. Experimental, Histochemical, and Ultrastructural Contributions to Our Understanding of Mammalian Pituitary Function ; 7. The Reproductive Biology of a Strepsirhine ; 8. The Phylogeny of Mineralized Tissues and 9. Influence of Chronic Exposure to Increased Gravity upon Growth and Form of Animals.

C. V. R.

Advances in Food Research (Vol. 13). Edited by C. O. Chichester, E. M. Mrax and G. F. Stewart. (Academic Press, New York and London), 1964. Pp. viii + 401. Price $ 14.50.

Volume 13 of this well-known series contains the following five contributions by the authors shown against each : 1. Recent Advances in the Freeze-Drying of Food Products, by Robert F. Burke and Robert V. Decareau ; 2. Etiological Status and Associated Studies of Pale, Soft, Exudative Porcine Musculature, by Earnest J. Briskey ; 3. Astringency of Fruits and Fruit Products in Relation to Phenolic Content, by M. A. Joslyn and Judith L. Goldstein ; 4. Fundamentals of Low-Temperature Food Preservation, by O. Fennema and W. D. Powrie and 5. Minimum Growth Temperatures for Food-Poisoning, Fecal-Indicator, and Psychrophilic Microorganisms, by H. David Michener and R. Paul Elliott.

C. V. R.

Differential and Riemannian Geometry. By Detlef Laugwitz. (Academic Press, Inc., New York), 1965. Pp. xii + 238. Price $ 8.50.

This is the English translation of Professor Laugwitz's *Differentialgeometric* originally published in 1960. As the author says in his Preface "This text-book is intended to be an introduction to classical differential geometry as well as to the tensor calculus and to Riemannian geometry". After a lucid first chapter on the theory of curves, tensor calculus notation is introduced in the second chapter on the theory of surfaces. Chapters three and four deal with Riemannian Geometry and its applications, and finally topics of global theory are presented in chapter five. This book should prove to be a suitable text-book on the subject for advanced students of mathematics and physics.

A. S. G.

Advances in Clinical Chemistry (Vol. 7). Edited by H. Sobotka and C. P. Stewart. (Academic Press, New York), 1964. Pp. xiv + 522. Price $ 16.50.

Volume 7 of the *Advances in Clinical Chemistry* contains the following six articles : (1) Principles and Applications of Atomic Absorption Spectroscopy, by A. Zettner ; (2) Aspects of Disorders of the Kynurenine Pathway of Tryptophan Metabolism in Man, by L. Muszjo and C. A. Benassi ; (3) The Clinical Biochemistry of the Muscular Dystrophies, by W. H. S. Thomson ; (4) Mucopolysaccharides in Disease, by J. S. Brimacombe and M. Stacey ; (5) Proteins, Mucosubstances, and Biochemically Active Components of Gastric Secretion, by G. B. J. Glass ; and (6) Fractionation of Macromolecular Components of Human Gastric Juice, by Electrophoresis, Chromatography, and Other Physico-chemical Methods, by G. B. J. Glass.

A perusal of the titles brings out the role that clinical chemistry plays in the progress of medical sciences ; it also shows the applications of such diverse physico-chemical methods as absorption spectroscopy, electrophoresis and chromatography in the study of diseases and their amelioration.

Published literature on the subjects is vast and growing as can easily be seen from the bibliography of references given at the end of each article. These critical review articles contained in the *Advances* serve to bring to the attention of scientists working in clinical chemistry and allied fields, the developments that are going on in the respective branches concerned.

A. S. G.

Optical Properties of Minerals—*A Determinative Table.* By Horace Winchell (Academic Press, New York), 1965. Pp. ix + 91. Price $ 5.00.

The identification of minerals by the use of their optical properties is well known. There are different types of charts which help to carry out the identification. One such familiar to petrographers is the three-dimensional chart of Winchell which uses hemi-cylindrical co-ordinates n_y, $2V$, and B ($= n_z - n_x$). An adaptation of this chart reduced to projection on a planar semicircle can be used with advantage for identification of a mineral with easy measurements of optical data (refractive index, birefringence and optic axial angle) carried out on thin sections or grains of the mineral.

The book under review is a convenient handbook for this purpose to mineralogists and

petrographers. It contains 31 carefully prepared semi-circular charts for successive ranges of n_y values from $1\cdot300$ to $> 2\cdot500$. Positions of the minerals are indicated in the chart by serially numbered points, and a key to these numbers on the page facing the chart enables to find out the name of the mineral. Against each mineral is given a page reference to *Elements of Optical Mineralogy—Description of Minerals* by Winchell and Winchell (Wiley, New York) from which details about the mineral can be obtained. Following this page reference are also given the spacings ("d") for the three or more strongest lines of the X-ray powder pattern. An Introduction of about 12 pages describes the principles of the charts and their use in practice.   A. S. G.

Environmental Control of Plant Growth. Edited by L. T. Evans. (Academic Press, New York and London), 1963. Pp. xvii + 449. Price $ 17.00.

The book contains the proceedings of a symposium held at the inauguration of Ceres, the Canberra phytotron in Australia in August, 1962, in which twenty-four experts from throughout the world have reviewed progress made in studies on the interactions between plants and their environment and the uses and limitations of a phytotron in such studies.

The physics of plant environments, the environment of plant surfaces, climatic control of plant-water relations, energy and water balance of plant communities, light relations in plant communities, gas exchange in plant communities, climatic control of photosynthesis and respiration, energy relations in plant communities, effect of climate on the distribution and translocation of assimilates and the mediation of climatic effects through endogenous regulating substances are the titles of papers which comprehensively deal with all facts of the plant environment and its effect on some of the most important physiological processes of the plant.

The above-mentioned papers are followed by a series of topics concerning plant reactions to the elements of the climate as studied under controlled conditions in phytotrons. These are : Effects of environment on metabolic patterns, control of plant growth by light ; climatic control of germination, bud break and dormancy ; climatic control of reproductive development and morphogenetic responses to climate.

The studies on plant-environment interactions have been extrapolated to field conditions which are examined in the papers entitled : Climate, weather and plant yield ; hardiness and survival of the extremes ; the genetic basis of climatic response and species and population differences in climatic response.

Phytotron as a tool for ecological and physiological researches has been investigated in the papers : the concept of a phytotron ; achievements, challenges, and limitations of phytotrons ; extrapolation from controlled environments to the field and the next decade (of phytotron researches).

The lively discussions following each of the papers in the symposium are faithfully recorded in the book which is a very effective document of man's efforts in understanding the plant-environment complex. Frankel concludes that in spite of the great complexity of the physical environment which impinges upon the plant an integration of many of the parameters is at least conceptually in sight but the position is not so hopeful in the biological field. Nevertheless, it is difficult to predict one way or the other when one looks to the most unexpected results cropping up from planned experiments.

The book is very useful and challenging to those interested in micrometeorology, physiology, experimental ecology, genetics, agronomy, horticulture, biochemistry and morphogenesis.

R. MISRA.

Books Received

Generalized Hypergeometric Series. By R. P. Agarwal, (Asia Publishing House, Bombay-1), 1963. Pp. 109. Price Rs. 5·00.

Caraka Samhita. By P. Ray and H. N. Gupta. (National Institute of Sciences, New Delhi-1), 1965. Pp. viii + 120. Price Rs. 15·00.

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Histological Techniques for Electron Microscopy (2nd Edition). By Daniel C. Pease. (Academic Press, New York), 1964. Pp. xv + 381. Price $ 9.50.

Structure and Activity of Enzymes. Edited by T. W. Goodwin, J. I. Harris and B. S. Hartley: (Academic Press, London, W. 1), 1964. Pp. viii + 190. Price 37 sh. 7d.

SCIENCE NOTES AND NEWS

Award of Research Degree

The University of Bombay has awarded the Ph.D. Degree in Botany to Kumari Lalitha Iyer, C. N.. for her thesis entitled "The Floral Anatomy of Some Rubiaceæ".

The University of Calcutta has awarded the D.Sc. Degree in Zoology to Shri Satyendra Narayan Chowdhury for his thesis entitled "Studies on Experimental Parthenogenesis, Merogony and Some Genetical Aspects of Silkworm *Bombyx mori* L. (Family Bombyciidæ) and Some Saturniils (Family Saturniidæ)"

The Utkal University has awarded the Ph.D. Degree in Medicine to Shri K. C. Sahu for his thesis entitled "Studies on the Incidence of Pathological Lesions of Skin in Intestinal Parasitic and Bacterial Diseases in Orissa".

Institution of Chemists (India)

The Sixteenth Associateship Examination of the Institution of Chemists (India) will be held in November, 1966. The last date for Registration is 30th November, 1965.

Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

Lady Tata Memorial Trust Scholarships and Grants for the Year 1965-66

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1965, the awards of scholarships and grants for the year 1965-66.

International Awards of varying amounts (totalling £ 8,100) for research in diseases of the blood with special reference to Leukaemias are made to: Dr. J. de Maeyer (France), Dr. A. Agostoni (Italy), Dr. G. Corneo (Italy), Dr. D. Quaglino (Italy), Dr. F. Squartini (Italy), Dr. G. Tridente (Italy), Dr. V. Buonassisi (France), Dr. J. W. Gorrod (U.K.), Dr. M. Matsuyama (Japan).

Indian Scholarships for scientific investigation having a bearing on the alleviation of human suffering from disease are awarded to: Dr. F. J. Daniel (Kanpur), Mr. A. K. Deshpande (Poona), Dr. (Miss) E. Lakshmi (Madras), Dr. (Miss) Nirmala Lakshminarayanan (New Delhi), (Miss) D. K. Manghani (Bombay), Dr. P. G. R. Pillai (Kanpur), (Miss) R. V. Prabhu (Bombay), Mr. R. Selvarajan (Madras).

Palynological Society of India

The Palynological Society of India, founded on 5 January 1965, has undertaken the publication of the *Palynological Bulletin* (Annual), to be issued in July–August, and the *Journal of Palynology* (Annual) to be issued in December, every year.

The membership of the Society shall be open to all those persons interested in the study of pollen and spores, in and outside India. Members, depending on the category, are entitled to free copies of both or one of the above publications.

Further particulars and membership forms may be obtained from Dr. P. K. K. Nair, General Secretary-Treasurer, Palynological Society of India, National Botanic Gardens, Lucknow.

Plant Diseases in Nyasaland

Mycological Papers No. 95 issued in August 1964 by the Commonwealth Mycological Institute, Kew, Surrey, England, is *A Supplementary List of Plant Diseases in Nyasaland* by D. C. M. Corbett. This bulletin (pages 16, price 7 sh. 6 d.) is a supplement to the *Plant Diseases of Nyasaland* published in 1953, and includes all collections made since 1953 mostly by the author.

Sucrose Determination by Ammonium Vanadate

C. P. Vinayak, N. R. Talati and S. P. Seth, Agricultural Chemistry Laboratory, Hanumangarh Junction (Rajasthan), write:

The determination of organic carbon was done colorimetrically by using sucrose as a source of organic carbon and ammonium vanadate as oxidising agent against the procedure of Datta et al. (*J. Ind. Soc. Soil Sci.*, 1962, 10, 67) where potassium dichromate was used as oxidising agent. The results indicate that ammonium vanadate was about four times more sensitive than potassium dichromate as a source of oxidising agent. A linear curve was obtained between sucrose concentration and colorimeter readings. The green colour developed was stable for more than 48 hours. This method appears to be preferable for determining organic carbon in soils.

THE NEW PHYSIOLOGY OF VISION

Chapter XXI. The Green Colour of Vegetation

Sir C. V. RAMAN

IN the present chapter and the following one, we shall concern ourself with the products of the plant world which are available in great variety as materials for a study of the relationships between the sensory perception of colour and the spectral characteristics of the light which is perceived. The nature of these relationships has already been ascertained from the observations described in earlier chapters. But the illustrations of the same which are furnished by studies of floral colour are particularly striking and impressive.

The most familiar of all plant colours is the characteristic green colour of foliage. The immensely important role played by the green leaves of plants in photosynthetic activity is well known. It is the absorption of light by the pigments present in the green leaves which enables them to play this role and it is the same pigments which determine the spectral character of the unabsorbed light emerging from the leaves on which depends their preceived colour. It is this relationship that invests the study of the colour of green leaves with special interest and importance.

Massed Display of Colour.—We may appropriately begin with a reference to the circumstances which enable vegetation to display colours with which we are all familiar. It is a characteristic feature of foliage that the two sides of each leaf present a different appearance. the difference in some cases being highly pronounced. One side of the leaf is smooth and exhibits vivid colour, while the other side has a rough surface and a dull colour. Invariably, however, the side which is smooth and vividly coloured is turned towards the light, thereby enabling the photosynthetic activity of the leaf to function. Further, the outermost leaves screen the interior of the plant or tree from observation. As the result, a mass of foliage from whatever direction it may be viewed exhibits the most brilliant display of colour which it is capable of. This feature of plant life contributes much to its attractiveness and explains why well-kept lawns, ivy-clad walls and trimmed hedges are much admired and extensively made use of around homes and in gardens. Indeed, the colour of vegetation is particularly impressive when seen from a dis-

tance where the individual leaves cannot be perceived. One may here recall the magnificent spectacle provided by a great stretch of rice-fields in deltaic areas. It is also worthy of mention that we can recognise even distant trees by the distinctive colour of their foliage.

The Development of Colour.—A special feature of interest which calls for explanation is the changing colour of vegetation which accompanies the growth and development of the leaves to full maturity. This is particularly obvious in the case of trees which drop all their leaves at a particular season of the year and begin again with a fresh suit of leaves when the season is propitious for their appearance and growth. But the same phenomenon can also be observed when new leaves are put forth on the growing stems of plants and trees. In general, the new leaves exhibit a greenish-yellow hue and this later alters to green and then progressively to darker shades of green. In some cases, the early leaves show other colours, appearing pink or even red ; but these hues soon give place to the colours normally exhibited by foliage. Some reference should also be made here to the colours exhibited by leaves when the time arrives for them to drop off from the tree. The change commonly observed is from a dark green to a bright golden-yellow. But there are cases in which the leaves put on a bright red hue before they fall off. The display of such vivid colours by the foliage of trees before the onset of winter is a regularly recurring event in the colder climates of the world.

Spectroscopic Studies.—Even the thinnest of leaves is opaque to light in the sense that it is not possible to view distant objects through it. This is a consequence of the scattering of light in its passage through the leaf. But sufficient light diffuses even through the thickest of leaves to permit of its spectral character being ascertained with the aid of a pocket spectroscope. For this purpose, the leaf may be held against the bright sky or if necessary in the path of a beam of sunlight, the slit of the instrument being placed close to the leaf so as to prevent entry of extraneous light. Alternatively, the smoother side of the leaf may be viewed through the spectroscope, the light being incident directly

on the surface under observation and emerging from inside the leaf after internal diffusion. In this method of examination, it is necessary to hold the leaf and view its surface at such an angle that the glitter due to reflection at the smooth surface of the leaf does not appear and vitiate the observations.

Very interesting results emerge from a comparative study of the leaves in different stages of growth from the same tree. For example, the mature leaves of the Jack-fruit tree (*Artocarpus integrifolia*) exhibit a dark green colour, while the small tender leaves are greenish-yellow, and three or four intermediate stages can be recognised between these extremes. The comparisons are best made by viewing the surface of each such leaf under similar conditions of illumination through the spectroscope, the leaf being held to the light at such an angle that the glitter due to the reflection at the surface is avoided. It is then noticed that despite the enormous differences in the colour of the leaf in various cases, the spectral range covered by the light emerging from the leaf remains the same, *viz.*, from 520 mμ to 640 mμ, these limits being set by the strong absorptions of the carotenoids and the chlorophylls respectively. The brightness of the spectrum shows a progressive diminution as we pass from stage to stage in the development of the leaf. But this cannot possibly account for the remarkable changes in colour.

A feature noticeable in the spectrum of the light emerging from the thinnest leaf is a perceptible weakening of the yellow region as compared with the green and the orange on either side of it. This feature is more conspicuous in the spectra observed with the leaves in the later stages of development. With the thickest of the leaves which exhibits a dark green colour, this feature is highly pronounced and a dark band can be seen in the spectrum in the region where the yellow should have appeared. This band appears as a clear demarcation between the two parts of the spectrum on either side of it. From these observations, it is manifest that the extinction of the yellow part of the spectrum is a requisite for the dark green colour to be exhibited by the leaves. In other words, the progressive change of colour that accompanies the development of the leaves is produced by the enhanced absorption of the yellow region of the spectrum by the leaf pigments.

The absorption of the yellow by the leaf pigments covers the wavelength range between 570 mμ and 586 mμ and appears between the green on one side and the orange and red of the spectrum on the other side. These colours may be observed in the spectrum when light falling on one side of the leaf and emerging on the other side of it is examined spectroscopically. They are equally well seen with the other method of observation described above. The green is definitely brighter than the orange and the red in all cases. But the difference is not great in the case of the thinnest leaves. The green gains in brightness relatively to the orange and the red as we proceed to the later stages of development of the leaf. But even in the case of the thickest leaves exhibiting a dark green colour, the orange and red regions continue to be observable and they are by no means of negligible brightness in comparison with the green. Since in these cases they make no perceivable contribution to the observed colour, we conclude that they are masked or prevented from being so observed by the more luminous green in the spectrum.

It is worthy of note that though these observations are as a matter of convenience best made using individual leaves, the same phenomena are also noticed when the spectroscope is directed by an observer towards any distant mass of foliage. Differences in the spectra of the same nature as those described above with individual leaves are noticeable in such cases as well.

Absorption Spectra of the Leaf Pigments.— Long ago, it was discovered by Sir George Stokes that the green pigment of leaves is a mixture of substances. Subsequent investigations have shown that the principal components are of two kinds, *viz.*, the carotenoids and the chlorophylls. Here, we are only concerned with the absorption of light by the mixture of pigments. Both the carotenoids and the chlorophylls can be extracted from the green leaf by prolonged immersion in organic solvents, the most suitable and effective of them being acetone.

Placing the acetone extract of the leaf pigment in a flat glass cell two centimetres thick, the colour as seen by transmitted light and its relation to the absorption spectrum of the solution can be readily ascertained. The colour can be seen by holding the cell against the sky or other extended source of light. To ascertain the nature of the absorption spectrum, the observer can hold the cell before his eye together with a replica diffraction grating and view the first-order diffraction spectrum of the linear source

of light provided by a tubular lamp with a straight tungsten filament stretched along its axis. Alternatively, the absorption spectrum can be viewed through a pocket spectroscope, and the positions of the absorption bands may be read on the wavelength scale provided in the eye-piece of the instrument.

A striking demonstration of colour changes entirely analogous to those exhibited by the leaves of plants in the course of their growth and development is possible with the acetone extracts of the leaf pigments. The glass cell is filled to about a third of its depth with acetone and then the acetone extract of the leaf pigments (which is itself of a deep green colour) is added a little at a time. The acetone in the cell first turns yellow in colour. Further additions alter the yellow to a greenish-yellow and then progressively to a clear green.

These changes correspond to the alterations in the character of the absorption spectrum of the solution. A cut-off of the red beyond 640 mμ appears at the very outset, and this is soon followed by the total extinction of the blue up to 500 mμ. But not until the band of absorption in the yellow between 570 mμ and 586 mμ appears and is fully developed does the solution exhibit a full green colour.

Some finer details observed with the green leaves themselves correspond to the features noticed in the absorption spectra of the leaf extracts. Particular mention may be made of the two *bright* bands noticed in the spectrum of the leaves, one in the green between 550 mμ and 570 mμ and the other in the orange between 586 mμ and 613 mμ. These bands are also noticeable in the spectrum of the transmitted light of the leaf extracts.

LIGHT AND IONISATION CURVES OF METEORS *

R. ANANTHAKRISHNAN
India Meteorological Department, Poona-5

1. INTRODUCTION

1.1. Meteors are tiny fragments of stony matter that enter the earth's atmosphere with high velocities which range from 12 to 72 km./sec. During their flight they get heated up and undergo ablation due to impact with the molecules of the atmosphere. The ablated meteor atoms which cascade downwards along the meteor trail collide with the air molecules and produce light and ionisation.

1.2. The majority of visual and photographic meteors appear and disappear between the heights of 120 and 70 km. in the upper atmosphere. The thermal velocities of the molecules of atmospheric gases at these levels are of the order of 0·5 km./sec. which are negligibly small compared with meteor velocities. According to the US Standard Atmosphere (1962), the mean free paths of the atmospheric molecules, the temperature and the scale height of the atmosphere at the meteor levels are as given in Table I.

1.3. The physical dimensions of the meteors are much less than the mean free paths of the atmospheric gases at meteor levels. Hence it is assumed that during its flight through the atmosphere the meteor body is subjected to direct molecular bombardment. The kinetic energy of the impacts gives rise to heating and ablation of the body. The heat of ablation of meteor matter is of the order of 6×10^{10} ergs/gm. while the kinetic energy of a meteor travelling with a velocity of, say 30 km./sec., is $4·5 \times 10^{12}$ ergs/gm., which is nearly 80 times the heat of ablation. As a consequence of this, the meteor does not undergo appreciable deceleration and its velocity remains nearly constant all along its flight through the atmosphere. Also, the ablated atoms leave the meteor body with practically the same velocity as the meteor.

1.4. Spectra of meteors reveal lines of neutral Fe, Ca, Mg, Na, Mn, Cr, Ni and Al and of singly ionised Ca, Mg and Si. The H and K lines of Ca$^+$ are noticed very prominently in the spectra of fast meteors while the D lines of Na are extremely strong in the spectra of slow meteors. The kinetic energy of the ablated meteor atoms

TABLE I

Height (km.)		120	110	100	90	80	70	60	50
Mean free path (cm.)	..	323	82	16·3	3·3	0·5	0·1	0·03	0·008
Temperature (°A)	..	349	257	210	185	181	217	255	271
Scale height (km.)	..	11·00	7·90	6·36	5·56	5·42	7·56	7·60	8·05

travelling with the velocity of the meteor ranges from 100 to 1000 eV. Collisions of the fast-moving meteor atoms with the atmospheric molecules result in the conversion of their kinetic energy into heat, light and ionisation.

2. ABLATION AND LUMINOSITY

2.1. The equation of meteor ablation follows from the principle of conservation of energy. Considering a spherical meteor of mass m and radius r and velocity v traversing vertically through the upper atmosphere of density ρ, the equation can be written as :

$$\zeta dm = \Lambda (\pi r^2 dz \rho) \frac{v^2}{2} \tag{1}$$

where dm = mass ablated in traversing the depth dz of the atmosphere ;

ζ = heat of ablation per unit mass of the meteor ; and

Λ = heat transfer coefficient.

$(\pi r^2 dz \rho) v^2/2$ is the kinetic energy of the air mass intercepted by the meteor in traversing the depth dz. The heat transfer coefficient Λ determines what fraction of this energy goes towards heating and ablation of the meteor. The value of Λ is generally much less than 1. It is a very important parameter in the theory of meteor ablation. In general, Λ may be expected to be a function of the meteor velocity v and of the atmospheric density ρ. In the conventional theory of meteor luminosity Λ is supposed to be independent of ρ and hence a constant for a given meteor.

2.2. The luminosity/ionisation equation for the meteor trail is written as :

$$I = \frac{1}{2} \left(\frac{dm}{dt} \right) v^2 \tau \tag{2}$$

In this equation I is the luminous/ionisation intensity at any point of the meteor trail, dm/dt is the rate of ablation of the meteor at that point and τ is the so-called luminous/ionisation efficiency factor that determines what fraction of the kinetic energy of the ablated atoms is converted into energy of light/ionisation. This is a very general equation which does not take into account the specific mechanism of excitation (leading to light emission) and ionisation.

2.3. Making use of the hydrostatic equation $dp = - g \rho dz$ and the gas equation, it follows from (1) that :

$$dm = - \frac{\Lambda}{\zeta g} (\tfrac{1}{2} \pi r^2 v^2) dp \tag{3}$$

If dr is the decrease in radius of the meteor due to ablation in falling through the height dz we have :

$$dm = 4 \pi r^2 dr \rho_m \tag{4}$$

where ρ_m is the density of the meteor.

From (3) and (4) we get

$$dr = - \left(\frac{\Lambda v^2}{8 \zeta g \rho_m} \right) dp = - \mathbf{A} dp \tag{5}$$

where A is a constant for a given meteor.

From (5) it follows that :

$$r = \mathbf{A} (p_e - p) \tag{6}$$
$$m = \mathbf{A'} (p_e - p)^3 \tag{7}$$

where p_e is the atmospheric pressure at the level of complete ablation of the meteor and A' is a constant.

From (7) and (2) it can be shown that :

$$\frac{dm}{dt} = K (1 - x)^2 x \tag{8}$$

and

$$I = K_1 (1 - x)^2 x \tag{9}$$

where $x = p/p_e$ and K and K_1 are constants for a given meteor.

From (8) it follows that I is a maximum for $x = 1/3$ and that :

$$I_{max} = \frac{4}{27} K_1 \tag{10}$$

From (8) and (9) we have :

$$\frac{I}{I_{max}} = \frac{27}{4} (1 - x)^2 x \tag{11}$$

Equation (11) expresses the luminous intensity at any point of the meteor trail in terms of the luminous intensity at the point of maximum luminosity. It is the equation for the *normalised meteor light curve*. As none of the parameters of the meteor enters into this equation it represents the light curves of all meteors. The same equation holds good for the variation of ionisation along the meteor trail.

In actual practice, the luminous intensity at different points of the meteor trail are estimated in terms of stellar magnitudes. In this case equation (11) can be written as :

$$\Delta M = M - M_{max} = - 2 \cdot 5 \log \left(\frac{I}{I_{max}} \right)$$
$$= - 2 \cdot 5 \left[2 \log (1 - x) + \log x + \log \left(\frac{27}{4} \right) \right] \tag{12}$$

In (11) and (12), $x = p/p_e = e^{-h/H}$ where H is the scale height of the atmosphere and h is the height interval between p and p_e (the distance of the instantaneous level of the meteor above the level of its complete ablation).

2.4. The normalised light curve of meteors given by equation (12) is represented by the curve in Fig. 1. The co-ordinates of this curve are ΔM and h. For constructing this curve a uniform scale height of 6·38 km. has been

assumed at meteor levels which is nearly the mean value of the scale height between 110 and 60 km.
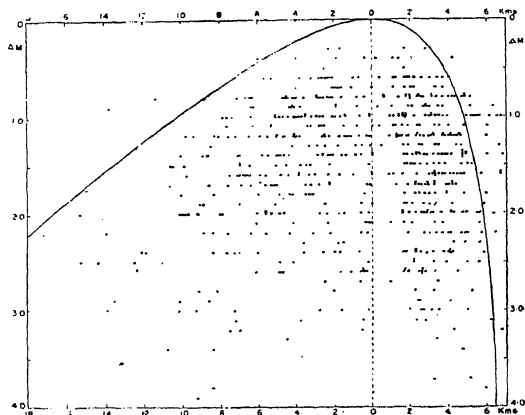
FIG. 1

3. DISCREPANCY BETWEEN THEORY AND OBSERVATION

3.1. Light curves of meteors have been studied by the two-camera photographic technique by Whipple and his collaborators in the U.S.A. In the post-war years high-speed and wide-angle Super Schmidt cameras have been employed for meteor photography yielding a wealth of information. The theory of meteor luminosity outlined in the previous section can be verified by comparing the actually observed light curves against the normal light curve predicted by theory. Such a comparison was made by Hawkins and Southworth (1958) in the following manner. On each meteor trail three points were chosen, two corresponding to the point of just appearance and just disappearance of the trail on the photographic plate and the third corresponding to the point of maximum intensity of the trail (M_{max}). The former points correspond to the limiting plate magnitude (M); $\triangle M = M - M_{max}$. The length of the beginning end end points of the trail from the point of maximum luminosity were evaluated from the photographs. Let these distances be a and b. Then on the normal light curve diagram (Fig. 1) each meteor is represented by two points with abscissæ a and b for the appropriate value of the ordinate $\triangle M$. The two points will thus lie respectively on the ascending and descending branches of the light curve. Pairs of points corresponding to a random sample of 360 Super Schmidt meteors were plotted in this manner. If the theory of meteor luminosity is correct, these points should cluster around the theoretical

curve. However, this was not found to be the case. All the plotted points were found to lie inside the curve as shown in Fig. 1.

3.2. This important finding of Hawkins and Southworth brought out conspicuously a serious discrepancy between theory and observation in respect of light curves of meteors. While sounding a note of caution about the validity of results of studies based on the normalised light curves of meteors, these authors also drew attention to the meteor fragmentation theory of Jacchia (1955) as a possible explanation for the discrepancy between theory and observation.

3.3. In two communications published in *Nature* the present writer (Ananthakrishnan, 1960, 1961) adduced reasons to show that the fragmentation theory of Jacchia cannot explain all the features brought by the Hawkins-Southworth diagram (Fig. 1) and that the conventional theory of meteor luminosity would appear to need modification to explain the observed facts. This conclusion was arrived at by eliminating from the Hawkins-Southworth diagram the majority of the fragmented meteors whose light curves are abnormal and examining the behaviour of the remaining meteors which constituted about a third of the total number. The nature of the discrepancy between theory and observation was thus highlighted, and it was shown that if the normalised light curve of the conventional theory is modified by assuming that the luminous efficiency factor τ in equation (2) is proportional to the atmospheric density ρ at every point of the meteor trail, the light curve so obtained shows better agreement with observation. However, no physical reason was adduced to support the assumed dependence of τ on ρ.

4. MODIFIED THEORY OF METEOR LUMINOSITY/IONISATION

4.1. A physically plausible reason for the modification of the conventional theory of meteor luminosity is found by a careful examination of equation (1) for meteor ablation. As mentioned in para 2.1, the conventional theory assumes that the heat transfer coefficient Λ is a constant for a given meteor throughout its flight. On physical considerations a dependence of Λ on ρ cannot be ruled out and hence it is necessary to enquire into the consequences of such a dependence. Let us assume that:

$$\Lambda = \lambda \rho^{\alpha} \tag{13}$$

where λ and α are constants.

In this case it can be shown that equations (11) and (12) for the normalised light curve
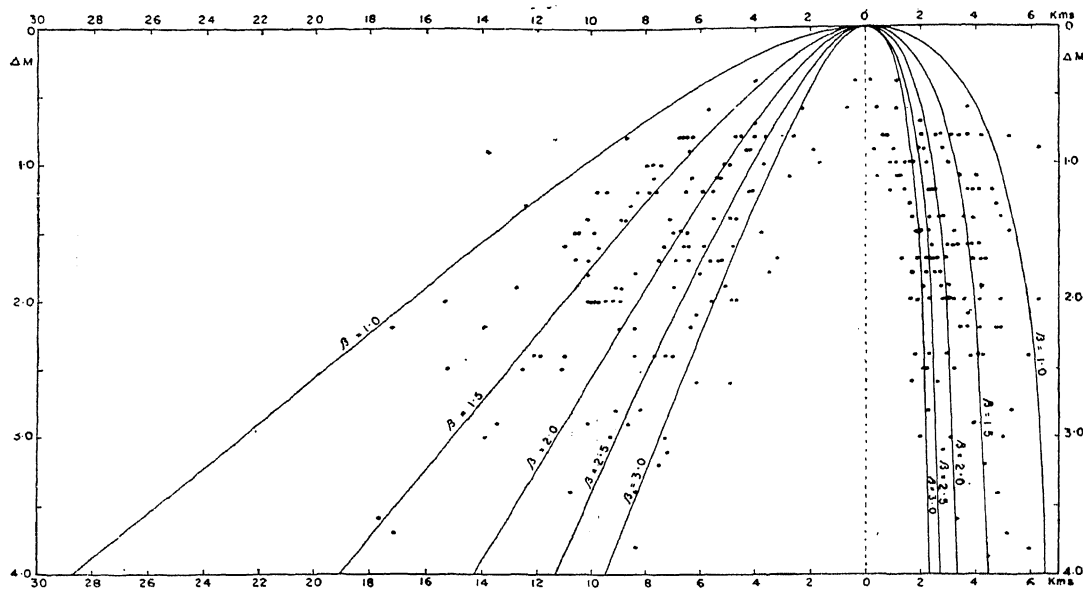
FIG. 2

transform as follows :

$$\frac{I}{I_{max}} = \frac{27}{4} (1-z)^2 \varepsilon \qquad (14)$$

$$\triangle M = M - M_{max} = -2 \cdot 5 \log \left(\frac{I}{I_{max}}\right)$$

$$= -2 \cdot 5 \left[2 \log (1-z) + \log \varepsilon + \log \left(\frac{27}{4}\right)\right] \qquad (15)$$

where $z = x^\beta = \left(\dfrac{p}{p_e}\right)^\beta$ and $\beta = \alpha + 1$.

Equations (14) and (15) have the same form as (11) and (12) except that z occurs in place of x.

4.2. Since $z = x^\beta$ the equations of the modified theory became identical to those of the conventional theory for $\beta = 1$. For values of $\beta > 1$, the ascending and descending branches of the light curve became increasingly steeper. However, for a given value of $\triangle M$ the ratio a/b (ratio of the length of the ascending branch of the meteor trail to the length of the descending branch) is the same for all values of β ; the lengths a and b and hence the total length $a + b$ of the meteor trail is inversely proportional to β. Fig. 2 gives the normalised meteor light/ionisation curves corresponding to $\beta = 1 \cdot 0$, $1 \cdot 5$, $2 \cdot 0$, $2 \cdot 5$ and $3 \cdot 0$. These correspond to the cases in which the heat transfer coefficient Λ is independent of ρ and to cases in which Λ varies as $\rho^{0 \cdot 5}$, $\rho^{1 \cdot 0}$, $\rho^{1 \cdot 5}$ and $\rho^{2 \cdot 0}$ respectively. The beginning and end points of the Hawkins-Southworth meteors have also been plotted in the diagram after eliminating the fragmented meteors with abnormal light curves in the manner explained in the author's earlier note (Ananthakrishnan, 1961). A dependence of Λ on ρ is

clearly brought out by the diagram. The light curve obtained earlier by the author by empirically assuming that τ is proportional to ρ lies between the curves corresponding to $\beta = 1 \cdot 5$ and $2 \cdot 0$ in Fig 2. This assumption is, however, no longer required to explain the discrepancy between the normalised light curve given by the conventional theory (curve for $\beta = 1$) and the plotted points. The dependence of Λ on ρ can fully account for the observed discrepancy. Although the observational points show a good deal of scatter, it appears that the normalised light curve corresponding to a value of $\beta = 2 \cdot 0$ would represent the light curves of meteors more correctly than that for $\beta = 1$. This would mean that the modified theory gives for meteor trails only half the length given by the conventional theory. This is in accord with the observational fact that observed meteor trails are considerably shorter than predicted by the conventional theory of meteor luminosity.

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2. —, *Ibid.*, 1961, **190**, 896.
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4. Jacchia, L. G., "The physical theory of meteors. VIII. Fragmentation as the cause of faint meteor anomaly," *Ap. J.*, 1955, **121**, 521.
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6. Whipple, F. L. and Hawkins, G. S., "Meteors," *Ibid.*, 1959. **52**, 519.
7. *Meteors*: Proceedings of a Symposium on Meteor Physics held at Jordell Bank Experimentation Station, University of Manchester, July 1954, Edited by Dr. T. R. Kaiser, Pergamon Press, 1955.
8. *U.S. Standard Atmosphere*, 1962: Prepared under sponsorship of NASA, USAF and US Weather Bureau.

REFLECTANCE STUDY OF SOME OF THE INDIAN COALS

S. K. BABU AND A. R. CAMERON

Coal Research Section, Geological Survey of Canada

INTRODUCTION

SINCE reflectance data along the lines described by Ammosov[1] (1957), Schapiro and Gray[2] (1961) are at present not available on Indian coals, it was decided to study the reflectance of some of the coals from Jharia, Raniganj coal fields (Bihar), Vindhya Pradesh coal field, Chirmiri coal field (M.P.), and the results constitute the subject-matter of this paper. It was suggested in one of the earlier publications by the authors[3] (1965), that detailed reflectance work would prove an invaluable criterion in evaluating the coking characteristics of the various Indian coals, as well as for a better industrial exploitation.

METHOD OF STUDY

Small random samples from seams No. 1, (5, 6, 7 combined), 8, 14, 16, 16-*a* from Jharia coal field ; Samla seam, Dishegarh seam, and Laikidih seam from Raniganj coal field ; seams No. 2 and 4 from Chirmiri coal field ; and Nawarazabad seam from Vindhya Pradesh were used for reflectance study. The samples were crushed to pass through 20 mesh, briquetted with an epoxy resin and polished with an automet to get an even and smooth polished surface. Also examined were four screen sizes (10 × 20 mesh, 20 × 35 m, 35 × 65 m, and − 65 mesh) prepared of small samples of coal from seams No. 16, 16-*a* of the Jharia coal field ; Dishegarh and Samla seams of Raniganj coal field ; and the Nawarazabad seam of Vindhya Pradesh. This study was undertaken to examine the variation in reflectance between different size fractions. For the reflectance measurements a Photovolt model 520 M photometer was used, and all readings were made on scratch-free vitrinoids, that were devoid of impurities.

RESULTS OF THE INVESTIGATIONS

According to the classification of Schapiro and Gray[1] (1960) based on reflectance studies, the Indian coals under investigation fall under the category of high volatile to medium volatile coals that are characterized by vitrinoid types V_4 to V_{13}. The high volatile coals, with vitrinoid types V_4 to V_9, are represented by the samples from Vindhya Pradesh, from Chirmiri and by the upper seams of Jharia and Raniganj coal fields ; the medium volatile coals, with vitrinoid

types V_9 to V_{12}, occur at the middle portion of the section of Jharia and Samla seam of Raniganj coal fields, while the bottom seam of Jharia coal field with V_{13} is nearly a low-volatile coal in rank.

Damodar Valley Coal Fields.—Damodar valley coal fields include the most important fields, chief among them being Raniganj, Jharia, Bokaro, Ramgarh and Karanpura. In this paper some of the seams from Raniganj and Jharia are described. The Raniganj coal field occupies an area of about 600 sq. miles in the province of Bihar and is situated 130 miles north of Calcutta. About 16 miles to the west and a little north of the Raniganj coal field is that of Jharia which encloses an area of 170 sq. miles.

The Damuda series is the coal-bearing series in these coal fields. It is divided into three subdivisions known as (*i*) Barakar measures, (*ii*) Barren measures, (*iii*) Raniganj measures. All the seams studied from Jharia coal fields for reflectance study come from Barakar measures ; while Laikidih seam belonging to Barakar measures and Samla and Dishegarh seams belonging to Raniganj measures were studied from Raniganj coal fields.

Figure 1 shows the stratigraphic sequence of the seams in the Jharia coal field. In this
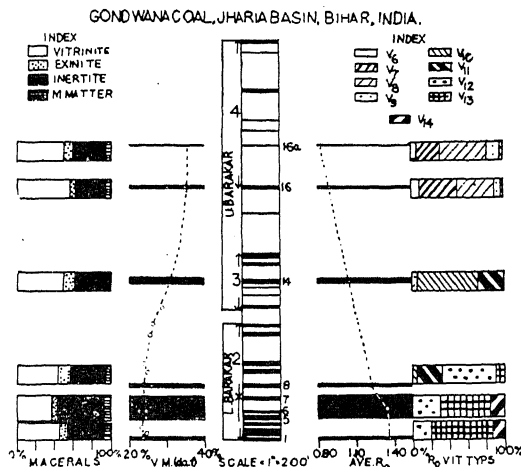
FIG. 1

sequence four stages, marked 1, 2, 3, 4, are recognized. Reflectance measurements were made on samples of each stage. They show a gradual increase in reflectance from the younger

to older seams, which is indicated by a decrease in vitrinoid types V_7, V_8 and V_9 and a corresponding increase of types V_{10}, V_{11}, V_{12} and V_{13}. This is illustrated in the percentage bar diagram on the right of Fig. 1. The average reflectance, also plotted, shows a nearly linear increase with depth. This increase of rank with depth has previously been demonstrated by Ganju[5] (1946) and by Lahiri[6] (1952) from chemical and refractive index studies respectively. Ganju showed the existence of a gradual loss in volatile matter when proceeding downward in the section. Ganju's volatile matter curve is illustrated on the left of the stratigraphic column. The present study indicates that not only chemically but also reflectance-wise the law of Hilt (1873) applies in the Jharia coal field. A similar relationship was observed in the coals of Raniganj coal field, but between these two areas the relationship is not apparent notwithstanding the fact that the coals of the latter are stratigraphically younger than those of Jharia.

The seams of Dishegarh and Samla of Raniganj coal field show lateral variation as noticed by an increase in reflectance from west to east. This lateral variation in the seams of Raniganj coal field has been mentioned by Ganju (1946) based on chemical studies.

Geographically the Bihar coals occupy the N.E. portion, the Chirmiri coals the central portion and the Vindhya Pradesh coals the N.W. portion of the Gondwana coal fields. The variation in average reflectance plotted in Fig. 2

REGIONAL VARIATION OF SOME OF THE COAL FIELDS OF INDIA BASED ON REFLECTANCE STUDY

FIG. 2

indicate that there is a decrease in rank of these coals from N.E. to N.W. Accordingly coals of high rank occur in N.E. portion, while coals of low rank are found in the N.W. part.

The average petrographic composition of the coals studied for reflectance from Jharia coal field are plotted by percentage bar diagrams as shown in Fig. 1. There is no apparent relationship indicated between the macerals with depth. However, it is clear from Table I, that

TABLE I

Name of the seam	Vitrinite content	Inertinite content
Raniganj (Average of 4 seams) ..	63·43	23·96
Jharia (Average of 10 seams) ..	48·16	35·60
Chirmiri (Average of 2 seams) ..	40·00	41·00
Vindhya Pradesh (Average of 2 samples)	45·10	40·00

there is a corresponding decrease in the proportion of vitrinite and increase of inertinite from Raniganj to Vindhya Pradesh coals (N.E. to N.W.).

The reflectance study reveals that the seams from the middle portion of the Jharia coal fields (Seams No. 8, 14) are likely better coking than those of the top and bottom portions, because they are characterized by those vitrinoid types which can impart fluidity during coking. The coals from Raniganj particularly those from the western part of the field, are regarded as coking coals, but they will not produce coke of good strength or stability. They are more suitable for blending purposes with other coking coals. Similarly coals from Chirmiri, although possessing enough vitrinoids, do not contain the required type to induce fluidity during carbonization. These coals also are more suited for controlled and proportional blending with other coals in order to produce a satisfactory coke produce.

In conclusion, it can be mentioned that a detailed programme of reflectance studies on the various coals of India, in co-ordination with chemical studies, will prove not only an invaluable tool in industrial application, but also will be useful in the academic understanding of the nature of various coals in time and space.

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LETTERS TO THE EDITOR

ON THE ENERGY LEVELS OF Mo^{92} WITH DIFFERENT POTENTIALS*

WARKE AND WAGHMARE[1] have shown that as long as the collective effects are neglected, calculations in nuclear spectroscopy do not depend much on the radial shape of the two-body nuclear potential. They illustrated this point with the use of Gaussian, Yukawa and exponential potentials. We have, however, carried out our calculations on Mo^{92} with the use of Coulomb potential as well. Table I lists

TABLE I

J E (MeV)		0^+	2^+	4^+	6^+	8^+
Experimental [2]	G.S.	1·54	2·33	2·66	2·79	
Gaussian	G.S.	1·44	2·37	2·67	2·79	
Yukawa	G.S.	1·64	2·37	2·64	2·79	
Coulomb	G.S.	1·73	2·44	2·68	2·79	

the energy levels of this nucleus arising due to the configuration $(g_{9/2})^2$. It is clear from this table that the values of the energy levels for Mo^{92} in the three cases are in quite good agreement with each other. This may help a lot in correlating the data of various authors obtained with different potentials, since the splittings of the levels do not depend much on the radial form of the two-body potential.

Physics Department,   VIJAY KUMAR.
Panjab University,   NARESH KUMAR.
Chandigarh, May 6, 1965.

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ABSOLUTE PHOTOELECTRIC CROSS-SECTIONS OF 145, 280 AND 320 KeV GAMMA-RAYS

THOUGH there are many theoretical expressions developed for the calculation of the photoelectric cross-sections, no single expression can be employed for all elements and for all energies especially in the low-energy region. Each expression is suitable to be used in a fixed region of energy and for a limited range of elements. All these are summarized in Grodstein's Tables.[1] The values generally used as standard values are obtained from interpolations made from the values obtained from various theoretical expressions. But recently Nagel[2] developed explicit expressions for both differential and total photoelectric cross-sections which suit all elements and all energies. Hultberg et al.[3] calculated the photoelectric cross-sections from Nagel's expressions between the energy region 120 to 662 KeV in lead and uranium only. So photoelectric cross-sections at 145, 280 and 320 KeV gamma-energies in elements Cu, Ag, Sn, Ta, Pt and Pb are computed from the recently developed Nagel's expressions and a comparative study is made in the light of the values computed from Heitler[4]-Stobbe[5] and Sauter[6]-Stobbe[5] expressions as well as with the interpolated values from Grodstein's Tables (NBS Circular 583).

In these calculations the screening constant $0·3$ for all the values of Z is used. Total cross-sections are obtained by using λ total/λ K values. Nagel's values are obtained from Dr. Hultberg, BESK Service, Nobel Institute of Physics, Stockholm, which are computed on computors. Total photoelectric cross-sections from Grodsteins Tables are plotted as a function of energy on graph sheets (75 cm. × 50 cm.). The interpolated values are obtained for the required elements at the required energies. The results are given in Tables I, II and III.

TABLE I
Photoelectric cross-sections at 145 KeV

Element		Heitler-Stobbe	Sauter-Stobbe	Nagel	NBS
Cu	..	9·95	10·6	9·6	10·5
Ag	..	77.20	86·2	74·9	78·6
Sn	..	96·9	108·2	96·3	100·0
Ta	..	417·3	465·5	421·7	442·5
Pt	..	527·2	586·7	535·2	552·5
Pb	..	627·2	700·9	637·1	688·0

TABLE II
Photoelectric cross-sections at 280 KeV

Element		Heitler-Stobbe	Sauter-Stobbe	Nagel	NBS
Cu	..	1·1	1·17	1·29	1·32
Ag	..	9·1	11·7	11·2	12·2
Sn	..	12·8	16·2	14·5	15·1
Ta	..	60·0	71·5	70·3	72·8
Pt	..	78·0	94·1	92·1	91·5
Pb	..	94·4	115·4	109·4	111·2

TABLE III

Photoelectric cross-sections at 320 KeV

Element	Heitler-Stobbe	Sauter-Stobbe	Nagel	NBS
Cu ..	0·74	1·01	0·87	0·94
Ag ..	6·77	8·85	7·62	7·97
Sn ..	8·4	11·54	9·99	10·55
Ta ..	40·5	55·7	49·5	52·1
Pt ..	52·6	72·3	64·7	65·5
Pb ..	63·7	87·6	79·1	79·6

It can be seen from the tables that Sauter-Stobbe values are higher at all energies and for all elements than all the other values. It can also be seen that the agreement between the Nagel values and the NBS values is better at 280 and 320 KeV gamma-energies while it is better at 145 KeV gamma-energy with the non-relativistic (Heitler-Stobbe) calculations.

The authors are highly thankful to Dr. S. Hultberg, BESK Service, Nobel Institute of Physics, Stockholm, Sweden, for sending the K-Shell Photoelectric cross-section. They are also thankful to the Department of Atomic Energy for sponsoring this scheme of work and for awarding a Senior Scientific Assistantship to one of them (K. P.).

The Laboratories for　　K. PARTHASARADHI.
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Andhra University,　　SWAMI JNANANANDA.
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SEPARATION OF LANTHANIDES USING PHTHALATE BUFFER

A WIDE variety of complexing and chelating agents[1-5] have been used as eluants for the separation of lanthanides by ion exchange. However, among simple carboxylic acid buffers, only acetate[4,5] has been investigated. The present communication deals with the behaviour of phthalate buffer as an eluant for the separation of the lanthanides.

An equimolar mixture of neodymium and praseodymium oxides weighing about 1·69 gm. was adsorbed on the top of a 2·2 cm. diameter,

60 cm. high column of 20-50 mesh Dowex 50 W $\times$ — 8 cation exchanger in the hydrogen form. Phthalate buffer (0·09 M) of pH 6·9 was passed at the linear rate of 1 cm./min. The compositions of the oxides obtained from the effluent fractions through their oxalates were determined spectrophotometrically using a Beckmann DU spectrophotometer. A typical chromatogram is shown in Fig. 1.
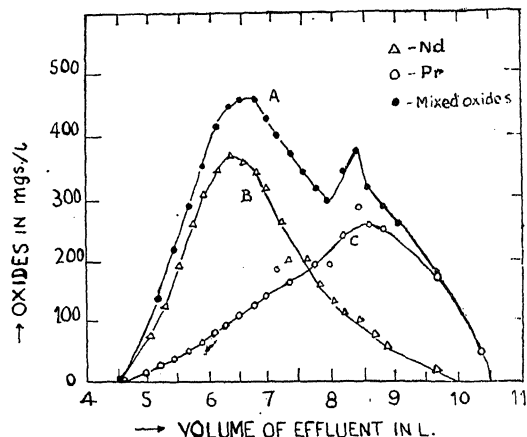
FIG 1. Elution curves of Nd-Pr mixture with phthalate buffer.

The results show that breakthrough occurs at about 4·5 litres. From the shape of the chromatogram it can be noted that the exchange follows only elution chromatography. Higher pHs which will favour the displacement chromatographic exchange could not be tried in view of the insoluble hydroxy complex formation. In the region where the composite elution curve A (Fig. 1) merges with the individual elution curves B and C for neodymium and praseodymium respectively, pure neodymium and praseodymium oxides were obtained. This is not apparent from the individual elution curves alone due to the inherent limitations in the analytical technique. The overlap of the individual curves B and C cover major amount of the lanthanides eluted. This is expected since the difference in stability constants of phthalates among the lanthanides are not considerable, even though the complexes formed are of considerable stability, log K_1 and log K_2 varying around 4 and 3 (M. Krishnamurthy and N. S. Krishna prasad, data to be published). Though the pure products are not obtained in bulk under these conditions there is enrichment of the lanthanide fractions significantly. Similar studies with mixed lanthanide oxides obtained from Indian monazite have indicated the

feasibility of obtaining the lanthanides individually in a pure form. Fuller details will be published elsewhere.

Chemistry Division,   N. S. KRISHNA PRASAD.
     Atomic Energy,   M. KRISHAMURTHY.
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Trombay, Bombay-28,
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THE KINETICS OF THE BROMINATION OF AROMATIC COMPOUNDS—PART II

IN a previous communication (Part I)[1] it was shown that the kinetics of the reaction between bromine and paradimethoxybenzene in acetic acid strictly obeyed a third-order rate expression. It is known[2,3] that only neutral molecules of bromine are participating in this reaction in aprotic solvents and that the transition state is more polar than the reactants. A heterolytic fission of the Br—Br bond occurs during the reaction. Therefore the reaction might be expected to proceed faster in a more polar solvent. To verify this we have carried out a similar kinetic study using nitrobenzene as solvent and the results are reported in this communication. We have not so far seen any published work on the kinetics of the bromination of aromatic compounds in nitrobenzene.

Rate measurements were made in the concentration range $1 \cdot 25 \times 10^{-3}$ to 5×10^{-3} M. The order of the reaction, calculated by the fractional-life period method, was found to be three. When the initial rates of the reaction (bromine reacted, 20%) in nitrobenzene and acetic acid at 30° C. were compared it was found that the reaction was 35 times faster in nitrobenzene than in acetic acid. The order of the reaction was also determined by the graphical method.[1] Figure 1 shows plots of $1/(a-x)^2$ against t for the reaction in nitrobenzene. Although the linear plots are not as satisfactory as in the case of acetic acid,[1] they clearly indicate that the overall reaction is essentially of the third order. The value of k_3 obtained from the slopes of the straight lines is $73 \cdot 8 \pm 0 \cdot 5$

litre[2] mole[-2] sec.[-1] at 30° C. From a plot of log k_3 against $1/T$ (temperature range 20° to 50° C.) the activation energy for the reaction was found to be $3 \cdot 6$ kcal. The complete expression for the rate constant was $k_3 = 3 \times 10^4$ exp. $(-3600/RT)$.
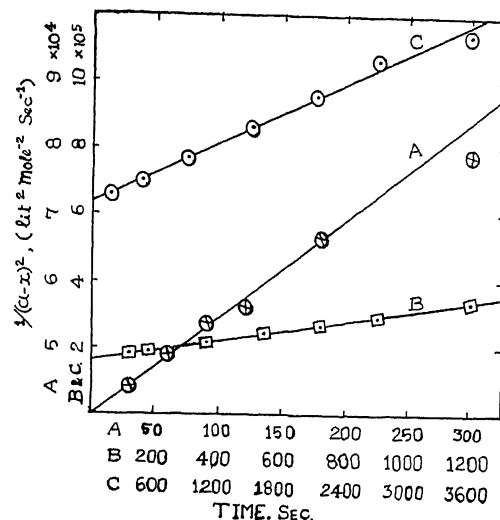
FIG. 1. Plot of $1/(a-x)^2$ vs. time for equimolar initial concentration of reactants (bromine and para dimethoxy benzene); A, $0 \cdot 005$ M; B, $0 \cdot 0025$ M; C, $0 \cdot 00125$ M. Temp. 30° C.

We find that the reaction is faster in nitrobenzene than in the less polar acetic acid. This observation is consistent with the broad features of the reaction outlined in the beginning.

Physical Chem. Dept.,   K. V. SESHADRI.
University of Madras,   R. GANESAN.
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CLEMMENSEN REDUCTION OF AN $\alpha : \gamma$ DISUBSTITUTED β-KETOESTER

IN connection with a synthetic sequence in this laboratory, Clemmensen reduction was applied to $\alpha : \gamma$ diphenylethylacetoacetate, a β-ketoester (by a Claisen condensation from two moles of ethylphenylacetate in the presence of isopropyl bromide[1]) in order to obtain the corresponding diphenyl butyric ester. The product was different from the expected deoxy ester. It is known that not many ketoesters have been

subjected to Clemmensen reduction. It is also observed that the Clemmensen[2] method of reduction may not be of general applicability in the case of α and β ketoesters. However a few β-ketoesters, ethylacetoacetate, ethylbenzoylacetate, methylester of 6-ketolithobilianic acid and two bicyclic (β-keto) esters have been reduced by Clemmensen procedure to the corresponding deoxy esters in yields varying from 30% to 59%.

We attempted the reduction of $\alpha : \gamma$ diphenylethylacetoacetate by employing the Clemmensen method under four different conditions : (A) In the presence of solvent (ethanol) miscible with aqueous acid, (B) In the presence of solvent immiscible with aqueous acid (toulene), (C) In the presence of toluene and a small amount of ethanol and (D) In the presence of absolute ethanol and dry hydrogen chloride.

In a typical experiment under procedure (D), the ketoester (21·0 gm., 0·075 moles), amalgamated zinc (135 gm.) and absolute ethanol (550 ml.) were saturated with dry hydrogen chloride gas and refluxed for ten hours. The cooled contents were again saturated with dry hydrogen chloride and refluxed for a second ten-hour period. The alcoholic solution was decanted from the residual zinc and most of the alcohol distilled off. The residue was cooled, diluted with water, extracted with ether, the ether extract washed, dried (sodium sulphate) and distilled.

Under procedure (D), described above, where dry hydrogen chloride and absolute ethanol are employed, the β-ketoester might not have undergone any alcoholysis or the removal of the carbethoxy group.[3] The removal of carbethoxy group under these conditions might have happened due to water formed by the action of ethanol on dry hydrogen chloride. A similar case of hydrolysis and decarboxylation under the conditions of Clemmensen reduction has been reported by Shirley and Schmidt.[4]

1 : 3 Diphenyl propane was identified by formation of a crystalline dibromo derivative. M.P. 112° C. (from methanol) (Requires C, 50·9% and H, 4·0% ; Found : C, 50·60% and H, 3·8%). The results were further checked by subjecting $\alpha : \gamma$ diphenyl ethylacetoacetate to ketonic hydrolysis to give dibenzyl ketone, B.P. 168–70° C./4 mm. (Semicarbazone, M.P. 140–41° C. from aqueous alcohol, Requires C, 71·9% and H, 6·4% ; Found : C, 71·8% and H, 6·5%) which was then reduced by Clemmensen procedure to 1 : 3 diphenyl propane. This compound was identical with the reduction product obtained by the four different procedures by virtue of the identity of the dibromo derivative.

Department of Chemistry, V. C. Devanathan.
University of Madras,   N. Arumugam.
Madurai Centre, *March* 18, 1965.

$$2\ C_6H_5 . CH_2 . COOC_2H_5 \xrightarrow{\ (CH_3)_2CHMgBr\ } C_6H_5{-}CH_2{-}CO{-}CH{-}COOC_2H_5$$

$$\underset{\displaystyle C_6H_5}{\big|}$$

$$\Big\downarrow \begin{array}{l}\text{Clemmensen}\\\text{Reduction}\end{array}$$

$$C_6H_5 . CH_2 . CH_2 . CH_2 . C_6H_5 \longleftarrow [C_6H_5 . CH_2 . CO . CH_2 . C_6H_5]$$
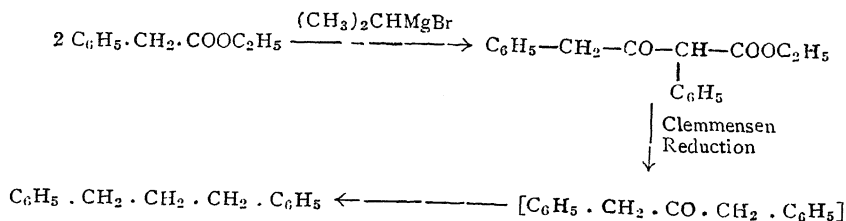
The reduction product in all these experiments was a pale yellow liquid boiling at 296–99° C. (140–44° C./3 mm.) η_D^{30} 1·5629, identified as 1 : 3 diphenyl propane. The yields of this hydrocarbon varied from 70% to 85% in the four different methods. The formation of this hydrocarbon was apparently due to the hydrolysis and subsequent decarboxylation of the β-ketoester under the conditions of the Clemmensen reduction to give dibenzyl ketone followed by the normal reduction of this ketone to the corresponding hydrocarbon. These transformations are shown above.

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OCCURRENCE OF 7, 4″-DIMETHYL-TECTORIGENIN IN THE FLOWERS OF *DALBERGIA SISSOO*

THE occurrence of three isoflavones, biochanin-A, tectorigenin and 7-methyltectorigenin, in the flowers of *Dalbergia sissoo* has been reported earlier.[1] The identification of another isoflavone, 7, 4′-dimethyltectorigenin, in the same source is described in the present communication.

The air-dried flowers were extracted by cold percolation with petroleum ether and then ether ; the ether extract, on concentration, deposited a white solid which was found to be a mixture of three substances by thin-layer chromatography [chloroform : methanol (9 : 1), silica gel G, alcoholic ferric chloride spray]. The two slower moving components were identified as tectorigenin and 7-methyltectorigenin by cochromatography with authentic specimens but the fastest moving substance did not correspond to any of the compounds isolated earlier from the flowers. This was obtained in a pure condition by refluxing the above crude solid with petroleum ether followed by repeated fractional crystallisation from methanol (yield, 31 mg. from 800 g. of flowers). The methanol mother liquors contained 7-methyl tectorigenin and the ethereal solution, after removal of these two compounds, contained tectorigenin.

The sparingly soluble compound mentioned above had m.p. 184° and was homogeneous when examined by TLC. Analysis agreed with the molecular formula $C_{18}H_{16}O_6$ and the presence of three methoxyl groups. It did not give a red colour on reduction with magnesium and hydrochloric acid in alcoholic solution ; however, a pink colour was obtained on reduction with sodium amalgam in alcoholic solution followed by acidification. This test indicated the isoflavone nature of the substance. The U.V. spectrum of the compound [$\lambda_{max.}^{EtOH}$ 267 mμ (log ϵ, 4·50); inflexion at 325 mμ (log ϵ, 3·60)] supported this inference and resembled those of tectorigenin and its derivatives. The compound gave a purple ferric reaction (becoming green with excess of the reagent) showing the presence of a chelated phenolic hydroxyl group ; this was supported by the insolubility of the compound in aqueous sodium carbonate solution. On acetylation (acetic anhydride-pyridine) a monoacetate of the formula $C_{20}H_{18}O_7$ (m.p. 211°) was obtained suggesting the presence of one hydroxyl group in the molecule.

Complete methylation of the substance (methyl sulphate-potassium carbonate in acetone) gave a monomethyl ether (m.p. 178°) which was identified as 5, 6, 7, 4′-tetramethoxy isoflavone by m.m.p. determination with an authentic sample. It was, therefore, concluded that the compound m.p. 184° is, most probably, 5-hydroxy-6, 7, 4′-trimethoxy isoflavone (7, 4′-dimethyltectorigenin). A comparison of its U.V. spectrum ($\lambda_{max.}^{EtOH}$ 267 mμ) with those in the presence of sodium acetate ($\lambda_{max.}$ 267 mμ) and of aluminium chloride (λ_{max} 275 mμ) supported this structure. A direct comparison (m.p. and m.m.p.) of the compound and its acetate with synthetic 5-hydroxy-6, 7, 4′-trimethoxy isoflavone and its acetate[2,3] established their identities.
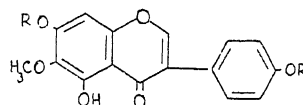
I   R = R′ = H

II   R = CH_3 ; R′ = H

III   R = R′ = CH_3

The occurrence of so many partial methyl ethers of 5, 6, 7, 4′-tetrahydroxy isoflavone in *Dalbergia sissoo* flowers may be of significance. The simplest of these is tectorigenin (I); the biogenesis of this compound is probably similar to that of the 6-methyl ethers of flavonoids which has been discussed earlier.[4,5] It seems to undergo stepwise methylation, first in the most active 7-position to yield 7-methyltectorigenin (II) and next in the 4′-position to form 7, 4′-dimethyltectorigenin (III). In these flowers the resistant 5-hydroxyl group is left unmethylated.

Department of Chemistry,   A. BANERJI.
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THE CRYSTALLINE PRINCIPLES OF EUPHORBIACEAE

Part III.* The Triterpenes of *Euphorbia neriifolia*, Linn.

I R,—OH (β)
II R,—OH (α)
III R,—O

IV

Euphorbia neriifolia, Linn.[1] (Sanskrit : Patrasnuhi) yields copious milky latex. The plant is valued in the indigenous medicine as a remedy for bronchial infection and abdominal disorders. The latex or any part of the plant has not been so far examined.

After the removal of rubber, the alcoholic extract of the latex (250 g.) was separated by concentration into two solid fractions. Fraction I (2 g.) was purified by chromatography over alumina using benzene-petroleum ether as eluant followed by crystallisation from methanol, m.p. 130–31° (compound A). Fraction II (0·7 g.), after chromatographic purification on alumina using petroleum ether as eluant, followed by crystallisation from methanol, gave compound B as colourless needles [$C_{30}H_{50}O$, m.p. 116–17° $(\alpha)_D^{30°}$ + 31° ; monoacetate, m.p. 108–09° $(\alpha)_D$ + 42° and a monobenzoate, m.p. 137–39° $(\alpha)_D^{30°}$ + 62°] identified as euphol (I)[2] by direct comparison with an authentic sample.

Compound A [$C_{30}H_{50}O$, m.p. 130–31° $(\alpha)_D^{32°}$+ 20°] is a monohydroxy triterpene yielding readily a monoacetate, m.p. 85–87° $(\alpha)_D^{32°}$ + 40° and a monobenzoate, m.p. 110–12° $(\alpha)_D^{32°}$ — 50°. (T.N.M. : pale yellow ; I.R : 860 cm.$^{-1}$ and 830 cm.$^{-1}$ for $>C=CH$; 1666 cm.$^{-1}$ for $>C=C<$). Lack of selective absorption around 220 mμ suggests that these double bonds are not conjugated. However, it readily absorbs a mole of H_2/Pd-BaSO$_4$ to give a dihydro derivative [m.p. 126–28° $(\alpha)_D^{32°}$ + 40°, acetate, m.p. 103–05°, $(\alpha)_D$ — 50° and benzoate, m.p. 124–25°]. Compound A on oxidation with sodium metaperiodate[3] yielded acetone suggesting the presence of an isopropylidene group and that this reactive double bond is similarly situated in the side chain as in euphol (I). The reactive double bond in compound A acetate shifts into a vinyl position (m.p. 119–21°) in presence of HCl as in euphol (I).[4] These facts establish that compound A is a new tetracyclic triterpene alcohol and hence named "Nerifoliol". It could be isomeric with euphol or tirucallol with different stereochemistry at C_3 or C_{17} or at other positions.
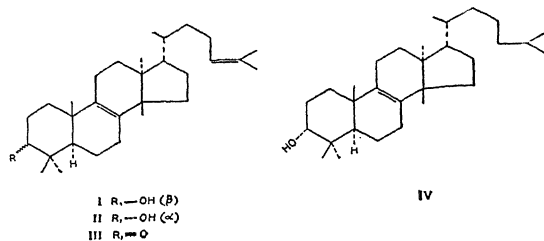
The first alternative was examined and nerifoliol gave a ketone with CrO_3 — HOAc [m.p. 118–19°, $(\alpha)_D$ + 79°] whose m.p. was undepressed by an authentic sample of euphone (III). The nerifoliol ketone was further reduced with $NaBH_4$-methanol to give a mixture of epimeric alcohols which could be separated by chromatography on alumina (eluants Pet. ether and Pet. ether-Benzene 1 : 1) into euphol (I, 80% yield) and nerifoliol (II, 10%). Nerifoliol is thus 3 α-hydroxy eupha-$\triangle^{8:24}$-diene (II) and this constitution is supported by the observation that dihydro nerifoliol (IV) suffered dehydration and no rearrangement[5] with POCl$_3$ in Pet. ether. In several other reactions nerifoliol (II) was significantly different from euphol (I).

3 α-hydroxy eupha-$\triangle^{8:24}$diene (II) was synthesised from euphone (III) earlier by Bennett and Warren[6] by the action of aluminium isopropoxide on euphone (III). But this isolation from a natural source is the first recorded occurrence. The trivial name "nerifoliol" is proposed to avoid any possible confusion if prefixes like α or β are employed, for the latter possess definite steric significance (*cf.* α-euphorbol which possesses 3 β-hydroxyl).[7]

One of us (D. N. R.) expresses his thanks to Sri. P. R. Ramakrishnan, Principal, Coimbatore Institute of Technology, Peelameedu, for study leave.

Dept. of Chemistry,   D. NAGESWARA RAO.
Andhra University,   L. RAMACHANDRA ROW.
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QUANTITATIVE SEPARATION OF COPPER^{II} AND CHROMIUM^{VI} BY SOLVENT EXTRACTION

EARLIER results from these laboratories reported the extraction of copper by pyridine from sodium formate solution.[1] A three-stage batch extraction procedure is used for the complete extraction of copper while chromium remains in the formate layer.

An aliquot of 8 M sodium formate required to give 5 ml. of 3 M sodium formate when diluted is taken to which the mixture of copper and chromium are added as copper chloride and sodium chromate respectively. The volume is made up to 5 ml. taken in a separating funnel containing 5 ml. of pyridine. Its pH is adjusted at 5·6–6·5 with ammonium hydroxide or hydrochloric acid. The mixture is shaken vigorously and allowed to settle and the pyridine layer separated. The extraction is carried out twice with 5 ml. pyridine. The copper content in the combined pyridine extracts is determined polarographically using ammonium acetate[2] as supporting electrolyte. The chromium content in the formate layer is determined by the iodometric method.[3]

The separation is quite rapid, accurate and the estimations were performed over a range of 1–6 mgs. of both the constituents with an accuracy of ± 0·2%.

Sincere thanks of the authors are due to Professor G. B. Singh for providing the necessary facilities.

Department of Chemistry,   G. S. DESHMUKH.
Banaras Hindu University,   A. L. J. RAO.*
Varanasi, *January* 11, 1965.

* Present Address: Department of Chemistry, Punjab University, Patiala.

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PAHUDIOXYLON DEOMALIENSE SP. NOV., A NEW FOSSIL WOOD FROM THE TERTIARY OF EASTERN INDIA

A NEW fossil wood of Leguminosæ is recorded here from the Upper Tertiary of eastern India, based on the material collected by Drs. Lakhanpal and Bose in December 1963 from the bed of the River Namsang near the headquarters of the Khonsa Forest Division at Deomali, Tirap Frontier Division, NEFA. As it shows the anatomical characters of the genus

Pahudioxylon Chowdhury, Ghosh and Kazmi (1960) and differs from its previously known species[1,2] it is being assigned to a new species, *Pahudioxylon deomaliense.* The genus *Pahudioxylon* shows the structural features resembling those of the modern woods of the genera *Afzelia* (including *Pahudia,* sensu Léonard, 1950) and *Intsia.*
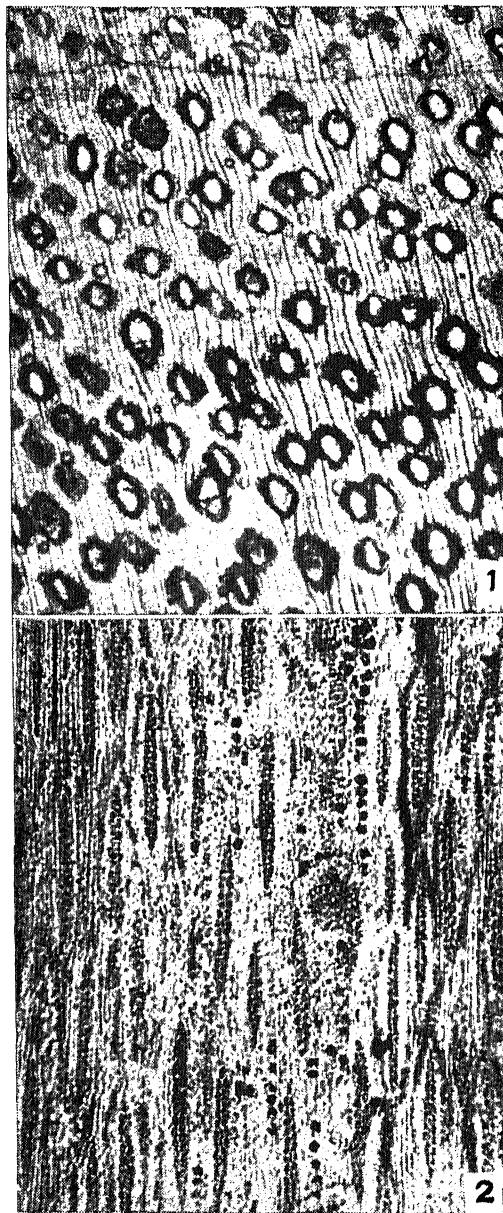
FIGS. 1-2. *Pahudioxylon deomaliense* sp. nov. Fig. 1. Cross section showing vessel distribution and parenchyma pattern, × 14. Fig. 2. Tangential longitudinal section showing the xylem rays, × 70.

The fossil wood is represented by a small piece of decorticated secondary xylem and shows the following characters : *Wood* diffuse-porous (Fig. 1). *Growth rings* distinct, delimited by smaller vessels and narrow lines of terminal parenchyma. *Vessels* small to medium-sized (Fig. 1), t.d. 90–225 μ, usually solitary, often in radial multiples of 2-3 or sometimes of 4 cells, 4-6 per sq. mm., circular to oval but mostly elliptical due to compression during fossilization ; tyloses and gummy deposits present ; vessel-members 150–450 μ long with truncate or tailed-ends ; perforations simple ; intervessel pit-pairs vestured, round to oval, alternate and about 6 μ in diameter. *Parenchyma* paratracheal and apotracheal (Fig. 1); paratracheal mostly aliform to sometimes aliform-confluent, obliquely aligning 2-4 or 5-6 vessels ; the apotracheal type occurring at the growth rings in 1-2 seriate narrow lines of terminal parenchyma. *Xylem rays* 1-3 seriate, mostly 2-3 cells broad (Fig. 2) and 9-14 per mm. ; ray tissue homogeneous with rays composed of procumbent cells only ; rays show storied tendency at some places. *Fibres* non-libriform, with big lumina, non-septate, and round to oval in cross-section.

Thanks are due to Dr. R. N. Lakhanpal for going through the manuscript.

Birbal Sahni Institute of   U. Prakash.
Palæobotany,
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CLONAL PROPAGATION OF MANGO (*MANGIFERA INDICA* L.) THROUGH CUTTINGS

THE rooting of hard wood cuttings from mature plants of mango, avocado and other trees is very difficult and attracted the attention of several workers. In a recent report to the International Horticultural Congress, Oppenheimer[1] has indicated that rooting of cuttings from mature mango trees could not be made a success so far by any worker. We have worked on this problem for some time because of its importance for clonal propagation of rootstocks which is of great value in consideration of the results achieved in apples at the East Malling Research Station. In our previous papers[2,5] we have reported that we have been able to induce rooting in shoots from young mango trees with hormones. In continuation to that work we took up studies with shoots of mango plants of seedling origin. Some of the shoots of these plants were beheaded in April and new shoots of a juvenile nature sprouted.[4] After etiolation of 15 to 20 days old juvenile shoots by covering with paper tube or black cloth for 45 to 60 days, the covering was removed and a ring of bark 2·5 cm. wide was taken out from the etiolated portion to which 5,000 p.p.m. IBA in lanolin paste was applied. IBA at same concentration was applied in the same way to all the treatments as given in Table I. After about 15 days when the callus formation just started, shoots were cut off from the mother plants in July and planted in pots, in a mixture of peatmoss and vermiculite in 1 : 1 proportion. These pots were then kept in an alkathene house, made humid by frequent water spray from a hand sprayer. The result achieved from the various treatments is presented in Table I.

TABLE I

Source and treatment	No. of cuttings planted	Percentage of cuttings rooted	Percentage of rooted cuttings established
Ten-year non-juvenile, non-etiolated (control)	20	30·00	16·66
Ten-year juvenile, non-etiolated	20	45·00	33·33
Ten-year non-juvenile, etiolated	20	35·00	28·57
Ten-year juvenile, etiolated	20	50·00	40·00

It will be seen from the data given in Table I that juvenile etiolated shoots of mature plants of 10 years age give the highest percentage of rooting and the highest percentage of establishment of rooted cuttings (Fig. 1).

FIG. 1. Rooting of mango cutting from etiolated, juvenile shoots of 10-year old tree.

This procedure of multiplication of rootstock clones will be further facilitated by another technique, which is found successful in our investigation, that is by stooling or layering of the rooted cuttings, after these have been taken from the selected rootstock clones.[3] It has also

been observed by us in a subsequent work that the shoots from bottom portion of the trees give higher percentage of success (55) in rooting and their survival, than those taken from the middle or the top portion. This is according to the findings as observed in apples and other plants.[6,7]

From a personal communication of Dr. Storey of Riverside, we understand that the rooting of Avocado cuttings is still a difficult problem. It is likely that some procedure as reported in the case of mango in the present paper will be useful in solving similar problems on Avocado.

The above observations and technique are likely to lead to a breakthrough in the standardization of clonal rootstocks of mango, as it will now be possible to multiply selected rootstocks clonally in combination with the technique of stooling and layering already reported by us.[5]

We are thankful to Dr. B. P. Pal, Director, for help and encouragement.

Division of Horticulture,   S. K. MUKHERJEE.
    Indian Agricultural   P. K. MAJUMDER.
    Research Institute,   N. N. BID.
New Delhi (India),   A. M. GOSWAMI.
April 5, 1965.

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STRUCTURE OF THE MALE REPRODUCTIVE ORGANS OF *ODONTOTERMES REDEMANNI* (WASMANN)

THOUGH the morphology of the reproductive organs of various species of termites has been discussed by a number of authors,[7-11,13] there seems to be some difference of opinion as to the structure of the male reproductive organs of the common mound building termite of east India, *Odontotermes redemanni*. While studying the functional morphology, histochemistry and cytogenesis in relation to reproduction of this species of termite,[1-6,12] I got opportunities to examine *in situ* the structure of its male reproductive organs at the de-alate phase—a generalized drawing of which is presented in Fig. 1.
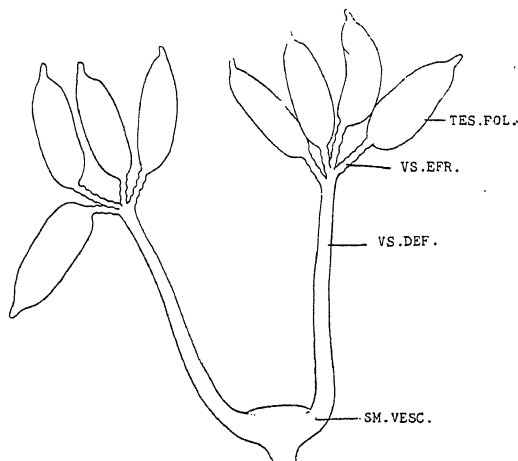
FIG. 1. Dorsal view of the male reproductive organs of the de-alate *Odontotermes redemanni* (Wasmann). SM. VESC., Seminal vesicle ; TES. FOL., Testicular follicle ; VS. DEF., Vas deferens; VS. EFR., Vas efferens. Only a few testicular follicles are shown for the sake of clarity.

The testes are located in between the seventh and eighth abdominal sternites and occupy a dorso-lateral position. They are enveloped by a very thin peritoneal membrane and are bathed in hæmolymph. The testes have a spherical outline and are equal in size, having an average diameter of $2 \cdot 5 \pm 0 \cdot 75$ mm. (N = 165). Each testis consists, on an average, of fifty long follicular tubes, which are so flexed and rolled as to form a bunch of bulbous swelling. Each testicular follicle is more or less cylindrical in outline with a short conical process at the tip. The follicle is of maximum width in the middle and narrows sharply at the posterior end to continue as the vas efferens. The vasa efferentia open radially into the expanded anterior end of the vas deferens. The vas efferens is an exceedingly narrow tube and notwithstanding its shortness, is thrown into convulations resembling epididymis.

The vas deferens, after receiving the vasa efferentia, passes ventrally and runs posteriorly below the coils of the intestine and on reaching the ninth abdominal sternite joins with its counterpart to form the seminal vesicle. Each vas deferens is a fairly thick tube with an approximate diameter of 2 mm. and runs nearly a straight course posteriorly.

The seminal vesicle is a wide chamber opening to the exterior through a narrow and

short duct. No tubular or accessory glands reported in other species of termites,[8,11,13] were found in *O. redemanni*. The seminal vesicle does not appear to store the sperms for a long time : its constituent cells only help in the smooth carriage of the seminal mass containing sperms[6] to the female. The term, seminal vesicle, since in this case does not store sperms in the strictest sense, may appear to be inappropriate and it can possibly be homologised to the caudal glands of *Neotermes*.[9] Whereas the caudal gland of *Neotermes* is supposed to play an important part in sperm nutrition, in *O. redemanni*, the seminal vesicle mostly helps in the transference of the sperms contained in the seminal case. The ejaculation of the seminal fluid is, of course, aided by the constrictions of the abdominal segments, the genital opening being located beneath the ninth and the tenth abdominal sternites.

The work was carried out while I was attached to the University of Calcutta.

Tocklai Experimental   BARUNDEB BANERJEE.
          Station,
Cinnamara, Assam, *March* 6, 1965.

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NOTES ON SOME *XANTHOMONAS* SPECIES DESCRIBED FROM SOUTH INDIA

CONSIDERABLE interest has been evinced in recent years in the phytopathogenic bacteria in India, particularly the genera *Xanthomonas* Dowson, and *Pseudomonas* Migula. Dr. G. Rangaswami and his associates have reported quite a large number of new species of phytopathogenic bacteria, many of them on very important economic hosts such as cereals, vegetable crops and ornamental plants. A book has also been published[2] on Bacterial plant diseases in India.

While making a monographic study of the genus *Xanthomonas* we had to examine the type cultures of the new species described by Rangaswami *et al.* The type cultures of many of these species which were deposited at the Plant Pathology Laboratory, in N.C.P.P.B., Harpenden, Herts, England, and with Dr. D. W. Dye, Plant Disease Division, Auckland, New Zealand, were also obtained for comparison. Detailed studies of all the new *Xanthomonas* species described by Rangaswami *et al.*, that were available to us, has led us to the conclusion that they failed to show characteristics of *Xanthomonas* species. Inoculation experiments also failed to give positive results. Dr. Dye who has made detailed comparative studies of the *Xanthomonas* species described by Rangaswami *et al.*, has informed us that none of the species examined by him is *Xanthomonas*. In the present paper a brief account of our studies on six species of *Xanthomonas* on cereals described by Rangaswami *et al.* is discussed. These are *Xanthomonas penniseti* Rajagopalan and Rangaswami[1] and *X. annamalaiensis* Rangaswami *et al.*[3] on *Pennisetum typhoideum* Rich., *X. maydis* Rangaswami, *et al.* on maize,[2] *X. rubrisorghi* Rangaswami *et al.* on sorghum millet,[2] *X. indica* Rangaswami *et al.* on Italian millet,[4] and *X. eleusineæ* Rangaswami *et al.* on the finger millet *Eleusine coracana* Gaertn.[4] While the type cultures of all these became available for study, *X. rubrisorghi* and *X. maydis* have not been formally described, but only the disease symptoms are mentioned.[2]

Cultural studies of these species on various media employed for studying *Xanthomonas* species showed that none of them belonged to that genus. Carbohydrate utilization tests also confirmed this fact. Some of the salient features are given in Table I.

All of them utilized salicin with acid production, with the exception of *X. maydis* and *X. rubrisorghi*. Even this single character removed these species from *Xanthomonas* group. *X. penniseti* produced acid and gas in dextrose, and it is doubtful whether any gas producer can ever be included among the *Xanthomonas* species. *X. rubrisorghi* cultures obtained from the authors as well as from Dr. Lelliott, Harpenden, Herts (N.C.P.P.B. 1565) are butyrous creamy white in colour, and is not a *Xanthomonas* species.

Inoculation experiments were carried out in the cases of *X. penniseti*, *X. maydis* and *X. indica* on their respective hosts. None of them was pathogenic when inoculated under optimum

TABLE I

Culture	Colony	Dextrose	Salicin	Lactose
X. annamalaiensis ..	Yellowish, forming fine slimy threads when taken on a loop; somewhat butyrous	Acid in 48 hrs.	Acid in 48 hrs.	Acid in 48 hrs.
X. eleusineae ..	Yellowish with somewhat reticulate surface, tough and tenacious; not butyrous	do.	do.	do.
X. indica ..	Smooth, whitish butyrous	Slight acid in 120 hrs.	Slight acid in 120 hrs.	Not utilized
X. maydis ..	Smooth, yellow and flowing to the bottom of the slant	do.	Not utilized	Slight acid in 120 hrs.
X. penniseti ..	Pale yellow and translucent and flowing growth	Acid in 24 hrs. and gas	Acid in 24 hrs.	do.
X. rubrisorghi (N.C.P.P.B. 1565)	Butyrous, whitish creamy growth	Slight acid after 96 hrs.	Not utilized	Acid after 120 hrs.

conditions. Only in case of *X. penniseti* when the organism was grown in liquid medium and was used for inoculating the plants, there was some scalding of the nature of acid burn. The organism produces strong acid in sugar media.

From the above studies based upon the type cultures it is apparent that none of them is *Xanthomonas* species or phytopathogenic bacteria. That a bacterial disease on these plants occurs in nature is possible, since we have ourselves seen and isolated a typical *Xanthomonas* in *Eleusine coracana* etc. But the names given for the bacterial pathogens refer to the isolates which are designated as type. Since none of these has shown to be true *Xanthomonas* species, the above six names referred to as new *Xanthomonas* species do not represent phytopathogenic bacteria.

Garda College, Navsari   M. K. Patel.
    and Hindustan   M. J. Thirumalachar.
Antibiotics Research Centre, Pimpri,
Poona, *March 19, 1965.*

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The genus *Xanthomonas* is not well defined in its physiological characters and according to Starr and Dye[1] "the systematics of these organisms is in a chaotic state". It may be true that a few of the species of *Xanthomonas* described from this laboratory do not possess typical characters of the genus, but to separate them out from this ill-defined genus and to describe them under any other old or new genus would cause more confusion than at present. There are already several confusions created

in the systematics of bacteria by the creation of such genera as *Chlorobacter*, *Phytomonas*, *Chainia*, etc., which are not accepted by other workers.

The diseases reported by us are of common occurrence in this part of India and the bacterial nature of these diseases has been established by us beyond any doubt. The observations of Patel and Thirumalachar[2] that one of the cultures was a gas producer and another was butyrous creamy white show that they were not dealing with the same cultures studied by us. Their vague report on negative results of inoculation studies 'under optimum conditions' may not be of much significance as they could not have used the same experimental conditions existing either at Coimbatore or Annamalainagar and also the same local varieties of host plants used by us for conducting the inoculation studies.

It is accepted by most workers on plant pathogenic bacteria that more detailed comparative studies are needed to clear the existing chaotic condition in the systematics of phytopathogenic bacteria. Until this is done, the yellow, cylindrical to elliptical, phytopathogenic bacteria producing acid but not gas from lactose and causing typical leaf-spot symptoms may continue to be classified under the genus, *Xanthomonas* Dowson.[3]

Microbiology Laboratory,   G. Rangaswami.
Faculty of Agriculture,
Annamalainagar,
June 23, 1965.

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CULTIVATION OF MANGROVE SEEDLINGS AWAY FROM THEIR NATURAL HABITAT

An attempt has been made to cultivate some species of mangrove at the Indian Botanic Garden, near Calcutta, almost in freshwater condition. All the species, which were selected for cultivation, were recorded by Prain[1] from the Sunderbans of Bengal. It is evident from the work of the previous authors[2-4] that high salt concentration favours the growth of some mangrove seedlings and helps in their cultivation away from their natural habitat. However, two well-known mangrove species, *Heritiera fomes* Buch.-Ham. and *H. littoralis* Dryand., have been found thriving well in almost freshwater condition in the Indian Botanic Garden along the edges of its Shadir Lake (T.S.S. varies from 635 to 1000 p.p.m.).[5]

A large number of seedling hypocotyls of varying length with no secondary root ramification and seeds were obtained from the Sunderbans in July, 1964, through the courtesy of the Conservator of Forests, Central Circle, West Bengal. The seedling hypocotyls were planted in large seed pans containing garden soil, white sand and leaf mould in 1 : 1 : 1 proportion. They were planted vertically in the soil with their radicle ends buried about 3 to 5 cm. within the soil depending on the length of the hypocotyls. The seed pans containing the seedlings were kept on an inverted pot placed in a freshwater bath constructed inside the Central Glass House of the Nursery No. 1 (Fig. 1). The seed pans were placed in such a way that the water touched the bottom of the seed pans to keep the soil moist. In case of seeds, they were sown in a pan containing the same type of soil and were placed in the same Central Glass House under similar condition. The results of germination, percentage of survival of the seedlings and their rate of growth are given in Table I.

The data given in Table I clearly indicate that the seed germination and early development of these mangrove species were not at all inhibited by the freshwater condition and moisture content of the soil. The growth rate of the seedlings, however, varied in different species of which, *Rhizophora mucronata* Lamk., *Bruguiera gymnorhiza* Lamk. and *Sonneratia apetala* Ham. particularly thrived well. The study will be continued after the seedlings are transplanted into the Garden soil.

I am grateful to Dr. J. Sen, Deputy Director, Botanical Survey of India, Indian Botanic Garden, Calcutta, for his valuable suggestions

FIG. I
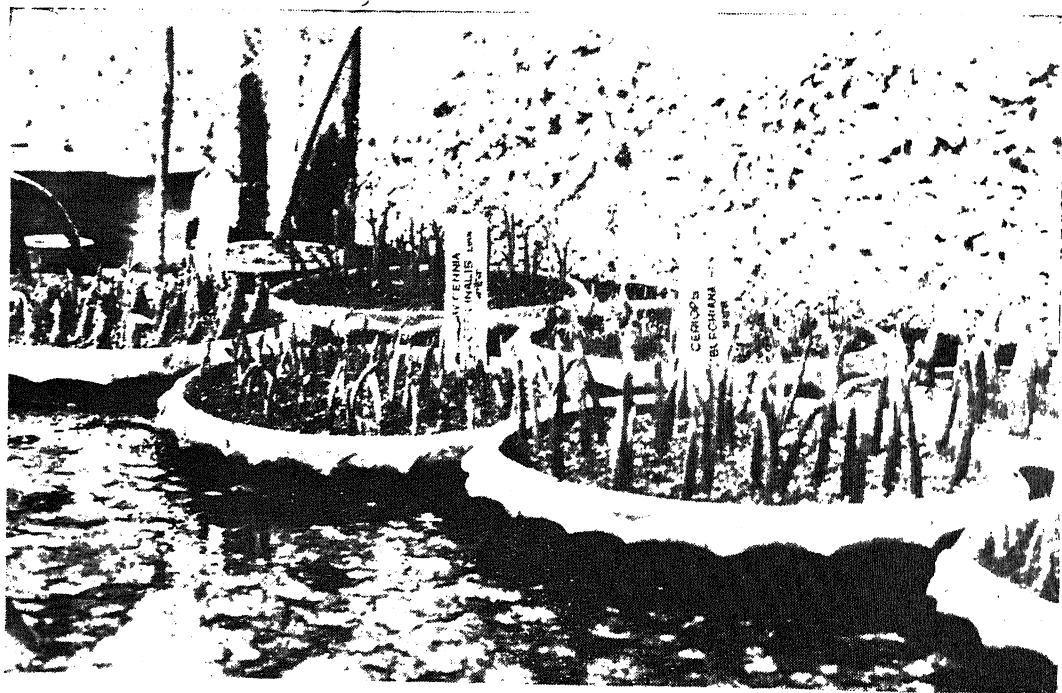
TABLE I

Name of the species	Seed or seedling hypocotyl sown/planted on 1-8-1964	P.C. of seed germination or seedling survival	Average number of leaves produced up to 1-11-1964	Height of the plant in cm.	Remarks
Rhizophora mucronata Lamk.	Seedling hypocotyl	99%	12+4 in axillary branches	48	Height calculated by subtracting the length of a hypocotyl from that of the entire plant
Bruguiera gymnorhiza Lamk.	Seedling hypocotyl	100%	14	35·5	
Ceriops roxburghiana Arn.	Seedling hypocotyl	82%	4	10	
Avicennia officinalis Linn.	Seedling hypocotyl	76%	4	7·5	
Sonneratia apetala Ham.	Seed	86%	12	45·2	
Excoecaria agallocha Linn	Seed	90%	13	18·1	

and encouragement. My thanks are due to Shri Prokash Kumar Roy for his assistance.

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P.O. Botanic Garden,
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RECENT FAUNAL DISCOVERIES IN THE HIMALAYAN PRE-CARBONIFEROUS ROCKS AND THEIR PALAEOGEOGRAPHIC BEARING

IN spite of the continuous progress in the study of the geology and palæontology of the Himalayan region certain important lacunæ have remained. One of these has been the complete absence of graptolites in this area, a hiatus which was[1] filled only in 1963 when the first specimens were discovered by one of the authors. The discovery of this group supports that the barrier supposed to exist between the Indian (Himalayan) region and Burma breaks-down.[2-5]

The graptolite specimens collected last year had been tentatively identified as *Didymograptus* (?) sp. The present collection (April-June, 1964) includes better specimens which can be referred, beyond doubt, to this genus, thus confirming our earlier identification, as well as

the Ordovician age of the strata. Barely 30 feet above the horizon whence *Didymograptus* sp. was collected some specimens of *Monograptus* sp. have also now been obtained. The horizon yielding *Monograptus* sp. is obviously referable to the Silurian.

In addition, another lacuna—the complete absence of fossils is the Muth Quartzite—which had existed since this formation was first described by Stoliczka[6] over a century ago, has also now been bridged by the discovery by one of the authors (V. J. G.) of a remarkably well-preserved fauna from Muth Quartzite. The age of this formation has been a puzzle because of the complete absence of fossils.

The large fauna from the Muth Quartzite includes the following species which indicates a Devonian age:

Phacops rana, Phacops sp., *Athyris spiriferoides, Meristella atoka, Spirifer* sp., *Stropheodonta interstrialis* (?), *Platyostoma lineata, Loxoplocus* sp., *Straparolus* sp., *Goniophora* sp., *Solenopsis* sp., *Modiomorphia* sp., *Lunulicardium* sp., etc.

Dept. of Geology, M. R. SAHNI.
Panjab University, V. J GUPTA.
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REVIEWS AND NOTICES OF BOOKS

Biological Effects of Magnetic Fields. Edited by Madeleine F. Barnothy. (Plenum Press, New York), 1964. Pp. ix + 324. Price $ 16.00.

The work proposes to provide a theoretical and practical background to all researchers who wish to engage in investigations in this area; and to compile in one volume detailed descriptions of all those experiments conducted in weak and strong magnetic fields that have resulted in demonstrable and reliable biological effects.

Following an introductory chapter which sets forth basic principles and covers the technical and mathematical problems related to biomagnetism, the effects of strong magnetic fields on specimens *in vivo* are covered. Observations on general development of specimens, tumors, hematological and genetic changes, mutations, the retardation of aging, and wound healing and tissue regeneration are given. Studies on the effects of strong magnetic fields on specimens *in vitro* produced observations on tissue respiration, inhibition of bacterial growth in fields of high paramagnetic strength, and of the activity of trypsin. The final section of the work reports studies on the effects of very weak magnetic fields.   C. V. R.

Progress in Infra-red Spectroscopy, Vol. 2. Edited by Herman A. Szymanski. (Plenum Press, New York), 1964. Pp. 298. Price $ 12.50.

The papers that comprise this volume are enlarged and updated versions of lectures presented at the advanced sessions of the Annual Infra-red Spectroscopy Institutes held at Canisius College, Buffalo, New York, in 1962 and 1963. There are nine chapters in this volume contributed by a "board" of contributors each discussing his own speciality. The titles of the chapters are as follows: 1. Polarized Infra-red Spectroscopy; 2. Infra-red Spectra of Crystals; 3. Infra-red Correlations for Organophosphorus Compounds; 4. Organometallic Spectra of Silicon, Germanium, Tin, and Lead; 5. Arsenic Trichloride as a Solvent for Infra-red Spectroscopy; 6. Infra-red Spectroscopy of Biological Materials 7. Near-Infra-red Spectroscopy: Theory, Instrumentation and Application; 8. Progress in Ultra-violet and Visible Spectrometry; and 9. Irrelevant Absorption in Quantitative Ultra-violet Spectrometry.

Although intended primarily as a reference work for the experienced spectroscopist, those beginning the use of IR spectroscopy as a research tool will also benefit by a study of the volume.

C. V. R.

The Nature of Induction Machines. By Philip L. Alger. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1965. Pp. xiii + 516. Price $ 25.00.

The book is the result of an extension in scope and updating of the earlier book by the same author entitled *The Nature of Polyphase Induction Machines*. It is intended to provide an understanding of the nature, design, and uses of both single-phase and polyphase induction machines, the most widely used forms of electric motor. There are 14 chapters, two more than in the earlier edition. New material in the book includes recent developments in induction motor design, and also recent developments in stepless speed control, including the use of silicon rectifiers with delayed firing angle to vary the motor voltage. The aim of the book is to provide a clear physical picture of each phenomenon, so that the importance and utility of any feature can be readily estimated; and to follow this with equivalent circuits and equations enabling calculations to be made to any desired degree of accuracy.

C. V. R.

Mathematical Theory of Probability and Statistics. By Richard von Mises. Edited and Complemented by Hilda Geiringer. (Academic Press, Inc., New York and London), 1964. Pp. xiv + 694. Price $ 22.00.

This volume presents a unified mathematical theory of the basic elements of probability and statistics, developed for use by both the mathematician and the scientist. Lectures given by Richard von Mises at Harvard University form the basis of this important work. They have been augmented by material from the great scientists' papers and notebooks, edited and widely supplemented by Hilda Geiringer.

The contents of the volume are given below: Fundamentals. Basic Properties of Distributions. Examples of Combined Operations. Summation

of Chance Variables. Characteristic Function. Asymptotic Distribution of the Sum of Chance Variables. Probability Inference: Bayes' Method. More on Distributions. Analysis of Statistical Data. Problem of Inference. Multivariate Statistics: Correlation. Introduction to the Theory of Statistical Functions. Four Appendices. Selected Reference Books. Tables. Index.
C. V. R.

Introduction to the Mechanics of a Continuous Medium. By L. I. Sedov. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A. and 10-15, Chitty St., London W. 1), 1965. Pp. xvi + 270. Price $ 12.50.

This book is designed as a text or reference for graduate students of mechanics, as well as for research workers. It is intended to provide a means for understanding the relationship of mechanics to geometry and thermodynamics, and to impart some momentum to the further development of macroscopic theory.

The book is essentially concerned with the fundamental physical concepts and principles used to construct representations of material bodies that occupy space in continuous fashion. It considers various examples of continuous media and process types, but discusses neither the properties of particular processes nor the solution of concrete problems on the motion of continuous media. The treatment throughout is precise—and quite detailed—and covers the fundamentals of classical mechanics of continuous media as well as modern methods and theories of models.
C. V. R.

The Proteins: Composition, Structure and Function (Vol. III). Edited by Hans Neurath. (Academic Press, New York and London), 1965. Pp. x + 585. Price $ 21.00.

The third volume under review contains chapters commencing from twelve to seventeen of the complete work. It presents four specific groups of proteins: the plasma proteins, the antibodies and antigens, the proteins of the blood clotting system, and the virus proteins. The tremendous extensions of knowledge of these four systems in recent years justifies this special coverage.

The topics covered include: the complex interactions which make up the blood clotting process; the structure and function of antibodies; the fractionation of proteins and the criteria of purity and the interaction of proteins with radiant energy.
C. V. R.

Nutrition—A Comprehensive Treatise (Vol. II) —*Vitamins, Nutrient Requirements, and Food Selections.* Edited by George H. Beaton and Earle Willard McHenry. (Academic Press, New York and London), 1964. Pp. xiv + 551. Price: List Price $ 18.50 and Subscription Price $ 16.50.

Nutrition, a three-volume comprehensive treatise presents, an up-to-date review of our knowledge of human nutrition. The first half of Volume II is concerned with metabolism, requirement, manifestations of deficiency of fat-soluble vitamins, the B vitamins and ascorbic acid. The remainder of the book is devoted to the philosophy of dietary standards, a comparison of dietary standards from many countries, the concept of nutritional adaptation and its significance in human nutrition, the causes and prevention of malnutrition, the factors affecting food choice, and patterns of food choice in many parts of the world. Each topic is treated in depth and includes comprehensive documentation. Recent advances in knowledge are emphasized.

Research workers in the fields of nutrition, biochemistry and physiology will find this treatise to be of great value, as well university teachers and graduate students in these areas.
C. V. R.

Science of Ceramics (Vol. 2). Edited by G. H. Stewart. (Academic Press, New York and London), 1965. Pp. 431. Price 84 sh.

This volume contains the proceedings of the second conference held under the auspices of the Ceramic Societies of Britain and Netherlands at Noordwijk-aan-Zee, Holland, in May 1963. In all, there are twenty-eight articles divided into four sections, *viz.,* I. Properties of Raw Materials; II. Processing of Materials; III. Behaviour During Firing; and IV. Structures and Properties of Products.

The volume will appeal to a wide readership extending from those concerned with the traditional ceramic industries to those working on the newer materials and their various applications in electrical, nuclear and mechanical engineering.

The topics covered include powder characteristics, the science of milling, rheological phenomena, powder compaction, diffusion, sintering and other microstructural changes at high temperature, solid-state reactions, surface properties, internal stresses, ceramic seals, solid oxide electrolytes, and glass-ceramics.
C. V. R.

The Theoretical Significance of Experimental Relativity. By R. H. Dicke. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. xii + 153. Price : Paper, $ 1.95 ; Cloth, $ 4.95.

This book is a reproduction of the article by the same author that appeared in the volume entitled *Relativity, Groups and Topology* and issued by the same Publishers, being the lectures presented at the Les Houches Summer School of Theoretical Physics, University of Grenoble, in 1963. The volume cited above has already been reviewed earlier in *Current Science*.

                         C. V. R.

Selected Problems in Quantum Mechanics. Edited by D. Ter Haar. (Macmillan, St. Martin's Street, London W.C. 2), 1965. Pp. vii + 402. Price 50 *sh.*

The book consists of two parts, *viz.*, (1) Problems and (2) Answers and Solutions. Under the first part there are nine sections and the second part contains correspondingly the same number.

This book is essentially an enlarged and revised second edition of a collection of problems contained in a text by Gol'dman and Krivchenkov augmented by a selection from a similar text by Kogan and Galitskii. These problems can be used either in conjunction with any modern text-book, or as advanced reading for anybody who is familiar with the basic ideas of quantum mechanics from a more elementary text-book.   C. V. R.

Progress in Chemical Toxicology (Vol. I). Edited by A. Stolman. (Academic Press, New York and London), 1963. Pp. xii + 436. Price 100 *sh.*

This volume, a new serial publication, presents vital information on problems confronting the toxicologist, clinical biochemist, pathologist, and pharmacologist.

The scope of the book is indicated by the eleven chapters whose titles and their respective authors are as follows : (1) Isolation and Separation Techniques for Identification of Poisons, by Henry C. Freimuth ; (2) Application of Gas Chromatography to Toxicology, by Leo R. Goldbaum, Eugene L. Schloegel, and Abel M. Dominguez ; (3) Aliphatic Alcohols, by Rolla N. Harger and Robert B. Forney ; (4) Acidic and Neutral Poisons, by A. S. Curry ; (5) Ataraxics and Non-barbiturate Sedatives, Aurhur J. McBay and Elvera J. Algeri ; (6) The Determination of Antiarthritics, Antihistamines,

and Thymoleptics, by Fredric Rieders ; (7) Narcotics and Related Bases, by Charles G. Farmilo and Klaus Genest ; (8) Toxicity of Air Pollutants, by Milton Feldstein ; (9) Analytical Methods for Air Pollutants, by Milton Feldstein ; (10) Poisonous Mushrooms, by Varro E. Tyler, Jr. and (11) Poisonous Seeds and Fruits, by Arthur E. Schwarting.

An extensive subject index given at the end of this volume enables ready reference to specialized areas in the literature.

                         C. V. R.

Recent Progress in Hormone Research (Vol. XIX). Edited by Gregory Pincus. (Academic Press, New York and London). 1963. Pp. xiii + 750. Price $ 22.00.

Recent Progress in Hormone Research (Vol. XX). Edited by Gregory Pincus. (Academic Press, New York and London), 1964. Pp. viii + 606. Price $ 21.00.

The Laurentian Hormone Conference is held every year in picturesque surroundings at Mont Tremblant Lodge in the province of Quebec, Canada. Volume XIX reports the Proceedings of the Conference held in the year 1962. In all, fourteen papers were presented and discussed. They dealt with the field under the following headings : I. Physical Methods in Hormone Research ; II. Steroid Hormones ; III. Hormones and Cellular Metabolism ; IV. Thyriod Hormone ; and V. Comparative Endocrinology. The material of the papers ranges from methodology to discussions of glandular normalities and abnormalities, cellular chemistry, and back to organismal adaptations, thus exhibiting the wide scope of endocrinology.

Volume XX reports the Proceedings of the Conference held in the year 1963. The fourteen papers presented and discussed covered the field under the following headings : I. Polypeptide Hormones, II. Control of Pituitary Hormone Secretion ; III. Hormones and Cellular Metabolism ; IV. Steroid Hormones ; and V. Testis Hormone Physiology.   C. V. R.

Dover Publications in Mathematics

1. **Theory and Application of Mathieu Functions.** By N. W. McLachlan, 1964. Pp. ix + 394. Price $ 2.35.

This is an unabridged and corrected reprint of the 1951 edition, the purpose of which is to give the theory of Mathieu functions and to demonstrate its application to representative problems in physics and engineering science.

It has been written for the technologist, and is not addressed in any sense to the pure mathematician. The text is in two parts, the first part deals with the theory and the second with applications of Mathieu functions to a variety of problems, which makes this work of great value to the technician.

2. **A Treatise on Advanced Calculus.** By Philip Franklin. 1964. Pp. xii + 595. Price $ 2.75.

This volume is an unabridged, unaltered republication of the original 1961 edition of the book. A section at the end of each chapter offers exercise problems (612 in all) for the use of teacher and student. These problems, together with the clear proofs and concrete accounts of theories and concepts, have helped to make this a standard text-book in advanced calculus.

3. **Foundations of the Theory of Algebraic Numbers** (Vols. I and II). By Harris Hancock. Vol. I: *Introduction to the General Theory*, 1964. Pp. xxvii + 602. Price $ 2.75 ; Vol. II: *The General Theory*, 1964. Pp. xxvi + 654. Price $ 1.75.

In addition to offering an approach to a higher and more generalized arithmetic through the systematic study of the algebraic numbers, Dr. Hancock's book is an invaluable source of information on the fundamental work of Camille Jordan, Minkowski, Hurwitz, Kronecker, Kummer, Dedekind, Hilbert, and scores of other modern mathematicians who laid the ground work for the theory. Its footnotes contain references to dozens of sources that can be used by students and teachers of advanced mathematics for more detailed study of specific topics, while the problems appended to many chapters are useful practice exercises.

4. **Indroduction to Higher Algebra.** By Maxime Bocher, 1964. Pp. xi + 321. Price $ 2.00.

This book has been for nearly half a century one of the most reliable and well-known texts in the field. It offers the basic material on fundamental topics of higher algebra. The book is comparatively brief, yet covers a large amount of material in its 300 pages and gives an elegant presentation of concepts and theorems in the literature. Its approach is always specific and concrete, in contrast to the present trend toward the abstract and the general—hence the content is easier to learn and understand. Further, it is a rich repository of theorems often neglected in more recent books.   C. V. R.

Advances in Communication Systems—*Theory and Applications* (Vol. 1). Edited by A. V. Balakrishnan (Academic Press, New York), 1965. Pp. x + 316. Price $ 11.50.

The object of this new series of *Advances* is to provide a permanent record of the developments that are taking place in this growing field of Communications Systems. The coverage will be broad and will include theory as well as applications and instrumentation.

The following contents of the first volume in the series will give an idea of the range of topics which may be expected in this continuing series of *Advances*: Signal Selection Theory for Space Communication Channels, by A. V. Balakrishnan ; Theories of Pattern Recognition, by David Braverman ; The Digilock Orthogonal Modulation System, by R. W. Sanders ; Telemetry and Command Techniques for Planetary Spacecraft, by J. C. Springett ; Communication from Weather Satellites, by R. A. Stampfl ; Information Theory of Quantum-Mechanical Channels, by H. Takahasi.   A. S. G.

Advances in Electronics and Electron Physics (Vol. 20). Edited by L. Marton. (Academic Press, Inc., 111, Fifth Avenue, New York-10003), 1965. Pp. x + 332. Price $ 12.00.

The wide range and applications of electronics, not only scientific but also humanitarian, are indicated by the following titles in this volume : Electrons as a Hydrodynamical Fluid by R. G. Fowler ; Plasma Oscillations by K. G. Emeleus ; Flame Plasmas by A. von Engel and J. R. Cozens ; Solar Radio Astronomy by A. Bioschot and J. F. Denisse ; Tropospheric Propagation by P. L. Rice and J. W. Herbstreit ; Electronics and the Blind by P. G. Shrager and C. Susskin.

A. S. G.

The Riemann Hypothesis and Hilbert's Tenth Problem. By S. Chowla. (Gordon & Breach, Science Publishers, 150, Fifth Avenue, New York-11), 1965. Pp. xv + 120. Price $ 6.50.

The author says in the Introduction that this is not a text-book but an elementary introduction to the topics mentioned in the title. Its object is to stimulate the reader on whose part some interest and knowledge in elementary number theory is assumed. Among the topics presented are : Character Sums, including Gaussian Sums ; A Formula of Jacobsthal ; The Mordell-Weil Theorem ; Some Special

Diophantine Equations ; Some Unsolved Problems ; Cyclotomy.

A. S. G.

Advances in Space Science and Technology (Vol. 6). Edited by Frederick I. Ordway. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. xvii + 444. Price $15.00.

The volume opens with a short but interesting article on Gravity by Prof. Bryce S. Dewitt in which the author presents our present state of knowledge on gravitation. The four sections of the article deal respectively with : (*i*) the observational description of the gravitational field ; (*ii*) the theoretical description including curvature, Riemannian geometry, Mach's principle, Dicke's theory and gravitational waves ; (*iii*) the experimental tests (including the three classical tests) and (*iv*) measurements in deep space in the near future, intermediate future and distant future.

There are three articles of a technical nature, *viz.*, Integration of Payload and Stages of Space Carrier Vehicles by G. K. C. Pardoe ; Navigational Instrumentation for Space Flight by S. Moskowitz and P. Weinschel and Space-Related Technology—Its Commercial Use by R. H. Waterman and L. G. Marts.

The final article, which covers nearly 200 pages with a hundred figures, is by M. R. Sharpe and J. M. Lowther on progress in rocket, missile, and space carrier vehicle testing, launching, and tracking technology. The article surveys the major facilities located in the United States.

A. S. G.

Books Received

International Review of Forestry Research. Edited by J. A. Romberger and P. Mikola. (Academic Press, New York), 1964. Pp. xi + 404. Price $13.00.

Survey of Progress in Chemistry. By A. F. Scott. (Academic Press, New York), 1964. Pp. xii + 345. Price $7.95.

Modern Organic Chemistry. By N. G. Clark. (Oxford University Press, Madras-2), 1964. Pp. x + 574. Price Rs. 28·00.

Modern Genetics (Vol. I). By J. A. Serra. (Academic Press, London W. 1), 1965. Pp. xi + 540. Price 105 *sh.*

Nuclear Interactions of the Hyperons. By R. H. Dalitz. (Tata Institute of Fundamental Research, Bombay-5 ; Oxford University Press, Mount Road, Madras-2), 1965. Pp. 106. Price Rs. 19·00.

Developments in Handling and Processing Fish. By G. H. O. Burges. [Fishing News (Books) Ltd., 110, Fleet Street, London E.C. 4], Pp. 132. Price £ 1–3–0.

Vitamin B_{12}. By E. Lester Smith. (Methuen & Co. Ltd., London E.C. 4), 1965. Pp. xii + 180. Price 25 *sh.*

Selected Problems in Quantum Mechanics. Edited by D ter Haar. (Macmillan, London W.C. 2), Pp. 402. Price 50 *sh.*

The Chemical Society Publication No. 18— Interatomic Distances and Configuration in Molecules and Ions. (The Publications Sales Officer, The Chemical Society, London W. 1), Pp. 208. Price £ 4–4–0.

Catalysis and Chemical Kinetics. By A. A. Balandin and A. Bielanski *et al.* (Academic Press, New York), Pp. xii + 255. Price $10.00.

Lectures on the Many Body Problem (Vol. II). By E. R. Caianiello. (Academic Press, New York), 1964. Pp. xi + 294. Price $10.50.

Silicate Science—Glasses, Enamels, Slags. By W. M. Eitel. (Academic Press, New York), 1964. Pp. xii + 707. Price $26.00.

Physical Properties of Magnetically Ordered Crystals. By E. A. Turov. (Academic Press, New York), 1965. Pp. xx + 222. Price $10.00.

Advances in Quantum Chemistry (Vol. I). Edited by Per-Olov Lowdin. (Academic Press, New York), 1963. Pp. xi + 385. Price 100 *sh.*

Crystal Chemistry of Tetrahedral Structures. By E. Parthe. (Gordon & Breach, Science Publishers, New York-11), 1964. Pp. xii + 176. Price $9.50.

The Nature of Induction Machines. By P. L. Alger. (Gordon & Breach, Science Publishers, New York-11), 1965. Pp. xiii + 516. Price $25.00.

The Fundamental Particles. By C. E. Swartz. (Addison Wesley Publishing Co., Mass.), 1964. Pp. viii + 152. Price $1.95 (paper bound).

Biology. By J. W. Kimball. (Addison Wesley Publishing Co., Mass.), 1964. Pp. xv + 704. Price $8.75.

Non-linear Problems of Engineering. Edited by W. F. Ames. (Academic Press, New York), 1964. Pp. xiv + 252. Price $10.75.

THE NEW PHYSIOLOGY OF VISION

Chapter XXII. The Colours of Flowers

Sir C. V. RAMAN

IT is appropriate that we commence this chapter by giving some indication of the magnitude of Nature's creative work as also of man's efforts to improve upon Nature in the production of floral colours. The best known of all flowers is the rose. No less than 421 named varieties of that flower are portrayed in full colour in the *Encyclopædia of Roses* (Blandford Press, London) which the enterprise of the publishers has made available to rose-lovers. It is no exaggeration to state that the varieties of rose developed of recent years and pictured in that book exhibit a surpassing loveliness of form and colour. Useful service has also been rendered by the Oxford University Press by the publication of their two books on Wild Flowers and Garden Flowers respectively. 887 species are described in the first book and 635 species in the second, accompanied in each case by 191 full-page plates in colour. Finally, mention may also be made of the volume entitled *Some Beautiful Indian Trees* published by the Bombay Natural History Society, describing and illustrating in colour the spectacular beauty of several of India's best-known flowering trees.

From the publications referred to above, it is evident that the colours exhibited by flowers are many and of varied nature. What we are concerned with here is the role played by human vision in the synthesis of the spectral components of the light diffused by the petals of flowers which gives rise to the colour sensation actually perceived. In many cases there is no obvious relationship or resemblance between the sensation that is actually perceived and the physical characters of the light which reaches the eyes of an observer. This situation reveals itself when the observer proceeds to study the colours of flowers with the aid of a direct-vision spectroscope. A wavelength scale in the eye piece of the instrument is extremely helpful for fixing the location of the observed features in the spectra.

The technique for a study of the kind indicated above is essentially the same as that explained in the preceding chapter on the green colour of vegetation. As in the case of foliage, the petals of flowers often exhibit a difference in the appearance of their two faces. The face that exhibits the more vivid colour is held and viewed in diffuse light of sufficient brightness to permit of the examination of the spectral character of the light that enters the petal and emerges again after internal diffusion. In the case of flowers, there is usually no observable reflection of light by their petals which could interfere with the observations. But if such a reflection is noticeable in any case, it can be avoided by holding the petal at the proper angle to the light. The petal under observation has to be held at some little distance from the slit of the spectroscope which is directed towards it. It has, therefore, to be of adequate size and the observations are therefore made most easily with flowers having fairly large petals. However, even when the petals are small, if they are grouped together side by side in the flower, the spectroscope can be directed towards the aggregate, this being held facing the light at an appropriate distance from the instrument. Satisfactory observations are then possible.

There is an alternative procedure which can be adopted in all cases and is often found useful. The petal is held up against the light and close to the slit of the spectroscope, and the light that penetrates through it is viewed through the instrument. This is possible since in all cases, the flower petals are sufficiently thin to allow light to come through, though there is no regular transmission. A comparison between the characters of the spectra as observed with the two procedures is instructive. In many cases, there are differences in brightness and also noticeable differences in the spectral characters. These may arise in two different ways. Firstly, there is a difference in the absorption paths which are effective in the two cases. Secondly, in the observation of the light which has passed through the petal, both of its faces are effective in absorption and if there is any difference in the nature of the absorbing material present on the two sides, this would manifest itself in the spectrum of the light which emerges.

The fact that impresses itself forcibly on an observer who has made an extensive study of

the material in the manner described above is the extremely important role played by the yellow sector of the spectrum, in other words, by the light included in the wavelength range from 560 mμ to 600 mμ in determining the perceived colours of flowers. In the preceding chapter, we have noticed that the foliage of plants does not exhibit its proper green colour unless the yellow of the spectrum has been more or less completely absorbed within the material of the leaves. The same phenomenon is even more conspicuously noticeable in respect of other colours. Indeed, it may be said that the presence or absence of the yellow sector in the light emerging from the petals of a flower makes all the difference in the colour which is perceived. No flower can exhibit a blue colour even feebly unless the yellow sector has been weakened by absorption and its place taken by a dark band crossing the spectrum. A vivid blue colour demands a complete extinction of the yellow sector and in addition a reduction in the intensity of the longer wavelengths in the spectrum. The removal of the yellow sector alone from the spectrum by absorption results in the colour of the flower being perceived as purple. But this may be modified so as more to resemble a red or a blue, if the red or the blue is stronger in relative intensity than is normally the case. Likewise, no flower can exhibit a proper red colour unless the yellow in its spectrum has been completely extinguished.

Classification of Floral Colours.—The facts of observation set forth above suggest a basis for a classification of the whole range of observed floral colours. We proceed by specifying the part or parts of the spectrum in which the absorption by the pigments present in the flower-petals is effective. For this purpose, the spectrum is divided into four sectors, in the following order, *viz.*, the blue, the green, the yellow and the red sectors, and their wavelength ranges are set respectively as from 400 mμ to 500 mμ, from 500 mμ to 560 mμ, from 560 mμ to 600 mμ and from 600 mμ to 700 mμ. It is possible, of course, that the absorption actually exercised in any of these sectors may be only partial, and that it may not extend over the whole of the sector. However, for developing a scheme of classification, the actual situation may be idealised by making the assumption that there is either no absorption or else a complete absorption of any particular sector. Considering these two alternatives and combining them for the four sectors, we have in all 16 different possibilities which may be

listed by writing down 1 as the symbol for complete transmission and 0 as the symbol for complete absorption of each of the four sectors. Thus, the list would commence from (1111) which would be the symbol for a white flower and end with (0000) which would indicate a flower which is totally black. When absorption of a particular sector in the spectrum is only partial, the case may be fitted into the general scheme by placing it in the category which it most nearly resembles and indicating the extent to which the observed colour differs from that noticeable in the ideal case.

We may illustrate the scheme of classification suggested above by some actual examples. Yellow is a colour very commonly exhibited by flowers. Amongst flowering trees, the Indian Laburnum (*Cassia fistula*) may be mentioned and also the well-known Copper Pod (*Peltophorum ferrugineum*), both of which are magnificent spectacles when in flower. Amongst garden flowers we may single out for special mention the gorgeous *Allamanda cathartica* which has huge bell-shaped waxy-yellow flowers which bloom all the year round. Spectroscopic examination reveals a complete extinction of the blue sector of the spectrum by its flowers, while the green, yellow and red sectors appear in full strength. Accordingly, this flower (and yellow flowers generally) would fall under the classification (0111).

Perhaps the most familiar example of orange-hued flowers in India is furnished by the magnificent sprays of flowers with which the climbing shrub *Bignonia venusta* covers the walls or screens over which it is allowed to grow up. The well-known aloe-wood tree *Cordia sebestena* also bears clusters of brilliant bell-like flowers of orange hue verging towards scarlet. Spectroscopic examination reveals a cut-off of the blue and green sectors of the spectrum while the yellow and red sectors are in full strength. Accordingly, orange flowers appear in the classification under the symbol (0011).

Amongst red flowers, one of the best known is the China Rose (*Hibiscus rosa sinensis*) which has large single bell-shaped blooms from which long bunches of stamens hang out. The petals exhibit a rich red hue. Spectroscopic examination shows a complete extinction of the blue, green and yellow sectors in the spectrum, the red sector commencing from 600 mμ being in full strength. Accordingly, red flowers may be classified as (0001).

If the absorption extends also into the red sector and covers wavelengths greater than 600 mμ, the colour of the flower would change from a bright red to a dark red or crimson and finally black. It would then belong to the category (0000). Such flowers could be regarded as intermediates between the categories (0001) and (0000). Likewise, those flowers in which the blue sector is absorbed in part while the green, yellow and red sectors are in full strength would exhibit a pale yellow colour. Such flowers may be regarded as intermediates between the categories (1111) and (0111). It is evident from what has been stated that the five categories (1111), (0111), (0011), (0001) and (0000) together with their intermediates would form a regular colour sequence in which a great many flowers would find a place.

Having dealt with the cases in which the blue sector of the spectrum is totally absent, we turn our attention to those in which the blue sector is present in full strength. There are eight categories of this kind which form two sub-groups of four each, *viz.*, (1111), (1110), (1100), (1000) and (1001), (1101), (1011), (1010).

Two items in the second sub-group are of particular interest, *viz.*, (1101) in which the yellow sector alone is absent and (1011) in which the green sector alone is absent, while all the other sectors are present in full strength. As has already been stated, the absence of the yellow sector alone would result in a purple sensation, while the absence of the green sector alone would result in the perception of a bright rose-red hue. Remarkably enough, illustrations of both these categories are furnished by the flowers of two distinct varieties of *Lagerstoemia flos reginae*, which is one of the most spectacular of Indian flowering trees. Its flowers appear in the months of April and May and are borne in great profusion from the ends of branches in large erect sprays. The tree is one mass of flower when it is in bloom. The petals of the flowers are six or seven in number and quite thin and crinkly, but they are nevertheless very colourful. Spectroscopic examination reveals a nearly complete extinction of the yellow sector in the case of the purple flowers, and of the green sector in the case of the rose-red flowers.

Blue Flowers and Their Spectra.—We may now usefully consider the class of colours represented by the symbols (1111), (1110), (1100), (1000) and (0000) together with their intermediates. These colours would be perceived if an absorption which commences at the long-wave end advances through the spectrum towards shorter wavelengths, covering up in succession the red, orange, yellow, green and then the blue, indigo and violet. The observed result would begin as white and end up as black. It is the step from (1110) to (1100), in other words, the extinction of the yellow sector of the spectrum which would be particularly significant, for a change of the perceived colour from white to blue would occur at this stage. The preceding step, *viz.*, the extinction of the red sector is, however, also important. For, the extinction of the yellow sector alone would give a purple sensation and not a blue.

All blue flowers exhibit in their spectra an absorption of the yellow sector. The more complete such absorption is, the more striking is the sensation of blue which results from its absence. In addition to the absorption of the yellow sector, the spectra of blue flowers also exhibit an absorption in the range of greater wavelengths. An absorption of the orange in the wavelength range between 600 mμ and 630 mμ is particularly effective in this respect. This is to be expected, since the luminosity of the spectrum falls off rapidly at still greater wavelengths.

To illustrate how the perceived colour which arises from an absorption of the yellow and adjoining regions of the spectrum varies with the strength of such absorption, the flowers of the Morning Glory (*Ipomea learii*) and of the Heavenly Blue (*Thunbergia grandiflora*) may be compared with each other. Both are climbing plants which are great favourites as they produce large and showy flowers in striking colour contrast with the green foliage. The Morning Glory exhibits a saturated blue colour, whereas the Heavenly Blue presents a hue which is somewhat different and much less saturated. The spectra of the two flowers are strikingly different. The spectrum of the Morning Glory exhibits the entire visible spectrum from violet to red in full strength except in the wavelength range between 570 mμ and 630 mμ which is strongly absorbed. The Heavenly Blue, on the other hand, exhibits rather weakly an absorption of the yellow between 570 mμ and 590 mμ and also an absorption in the red around 630 mμ. But the orange of the spectrum is not absorbed and is seen as a bright band with darker regions on either side. A dimming of intensity is also noticeable in the spectrum around 540 mμ in the green sector. It is worthy of remark that a spectrum very

similar to that of *Thunbergia grandiflora* is exhibited by the flowers of *Jacaranda mimosifolia,* which is a spectacular tree bearing during the months of March to May an immense canopy of flowers and buds of a beautiful blue-violet colour.

Bougainvilleas.—We shall now proceed to consider some individual cases presenting features of special interest. The Bougainvilleas form one of the most conspicuous and colourful features in Eastern gardens. They are very ornamental, grow vigorously in any soil with very little attention and can be adapted to various purposes. There are several natural varieties and numerous others have also been developed by horticulturists which present attractive colours. What appear to be its blooms are really the trios of brightly-coloured bracts which surround the true flowers.

One of the familiar varieties known as *B. rosa catallina* has very large rose-coloured bracts. Spectroscopic examination shows it to belong to category (1011), the green being strongly absorbed. There are also numerous varieties which exhibit different shades of purple. One may recognise amongst them a typical purple belonging to the category (1101) in which the yellow sector is absent while the green is present in fair strength. Other varieties may be described as exhibiting a rose-purple colour and can be classed as intermediates between the categories (1011) and (1101). The varieties exhibiting a red colour show a complete extinction of the yellow sector which adjoins the red. But the spectroscope reveals that the green and the blue sectors are also present though with relatively low intensities.

The Aster and Its Varied Colours.—The aster is well known everywhere as one of the most showy of flowering shrubs. Each individual flower with its large feathery head and a gaily-coloured centre makes a most attractive picture. The asters commercially grown at Bangalore and exhibiting marked colour fall into two distinct classes. In each class one observes a progression of colour. In Class A the colour observed ranges from a bluish-purple to a deep violet. In Class B the colour observed ranges from a pale pink to a bright rose-red. A casual observer looking at the flowers might imagine that the asters of Class A absorb the longer wavelengths in the spectrum and therefore appear blue or violet, while the asters of the Class B absorb the shorter wavelengths and therefore appear red. Nothing could be further from the truth.

Spectroscopic examination reveals that the two classes are totally different in the nature of absorption which give rise to the perceived colours. The spectra in each class exhibit certain common features but there is a progressive change in the strength or intensity of the observed spectral features. The perceived colours of the asters in Class A have their origin in a readily observable extinction of the yellow sector in the spectrum. The absorption exhibits a well-defined edge at about 600 mμ, longer wavelengths having their normal intensities, while the absorption in the region of shorter wavelengths falls off progressively and becomes insensible at about 560 mμ. This absorption is moderately strong for the asters which appear purple-blue, quite strong for the asters which appear purple-violet and is total for those which appear of a violet colour. Apart from the strong absorption in the yellow, there are also indications of a minor absorption at 650 mμ which results in the red sector of the spectrum appearing bifurcated. This is a feature which is just noticeable in the purple-blue asters. But it is more clearly seen in the spectra of the asters of a deeper colour, *viz.,* those which appear of a violet hue.

The asters in Class B show a spectrum in which the violet, blue, yellow, orange and red sectors in the spectrum appear with their usual intensities, while in the green sector, there is a sensible weakening, especially between 530 mμ and 560 mμ, the maximum of absorption appearing at about 545 mμ. This absorption is noticeable with the pink asters; it is quite strong with those which appear as bright pink, and nearly complete with the rose-red asters. It is evident from these facts of observation that the asters of Class A fall in the colour category (1101) and the asters of Class B in the category (1011).

CRYSTAL STRUCTURE OF L(+) CYSTEINE HYDROCHLORIDE MONOHYDRATE*

R. RAMACHANDRA AYYAR AND R. SRINIVASAN

Centre of Advanced Study in Physics, University of Madras, Madras-25

1. INTRODUCTION

THE determination of the crystal structure of L(+) cysteine hydrochloride monohydrate was undertaken as a part of a series of structure determinations of amino-acids and related compounds in this laboratory. The structure of cysteine is of interest in view of the fact that cysteine readily oxidises into cystine in which the disulfide bridge is significant in the folded configuration of proteins.

While much work has been done on cystine and its derivatives,[1-4] little work has been done on cysteine.[5]

This is a preliminary note on the structure which has been established in all its essential details. Detailed report after complete refinement of the structure will be published in due course.

2. EXPERIMENTAL

Good crystals of L(+) cysteine hydrochloride monohydrate were grown by slow evaporation of an aqueous solution and were obtained as needles along [001].

Oscillation and Weisenberg photographs taken with CuK_a radiation gave the following cell dimensions:

$$a = 19 \cdot 48 \text{ Å}, \ b = 7 \cdot 12 \text{ Å}, \ c = 5 \cdot 52 \text{ Å}$$

The zero, first, and second layer Weisenberg photographs taken about the needle axis (c) and Buerger precession photographs of the $a^* c^*$ and $b^* c^*$ reciprocal lattice planes showed that the general systematic absences were only in $h00$, $0k0$, and $00l$ reflections for h, k, and l odd respectively thus fixing the space group uniquely to be P $2_1 2_1 2_1$.

The density of the crystals determined by the method of floatation using a mixture of benzene and bromoform was $1 \cdot 51$. g./c.c. This leads to the total weight of the unit cell to be 696 while the calculated value assuming four formula units of $C_3H_8NO_2SCl$, H_2O, in the unit cell comes to be 700 thus clearly establishing that the compound is a monohydrate.

Intensities were recorded on multiple films using the equi-inclination Weisenberg technique for $hk0$, $hk1$, $hk2$, and $hk3$ reflections and were measured by visual estimation against a standard intensity strip recorded for the same crystal. They were then reduced to the absolute scale by Wilson plots.

3. DETERMINATION OF THE STRUCTURE

The positions of the heavy atoms, chlorine and sulphur were determined by interpreting peaks from a sharpened Patterson map of the c and b projections. It was noticed that while the single peak due to Cl-Cl interaction could be identified in the unsharpened Patterson of the c projection, that due to the S-S interaction could not be so identified though the strength of this peak also was expected to be nearly the same as that for the Cl-Cl one. This was presumably due to the effect of overlap of peaks. However, a sharpened Patterson using the function $[(\Sigma Z_j/\Sigma f_j)^2 - 1]$ for sharpening brought out the S-S interaction single peak convincingly. The merits of this sharpening function are being studied and will be reported later.

The rest of the structure was worked out in both the c and b projections by the beta general synthesis[6] whose superiority over the heavy atom phased synthesis has been demonstrated recently.[7] In the present case, chlorine and sulphur were used as the known (P) atoms. All the remaining atoms could be fixed from these syntheses. A structure factor calculation with the co-ordinates of all the atoms as determined from these maps gave an R value of 28% for both the c and b projections.

The structure was then refined by three-dimensional least squares refinement with individual isotropic temperature factors for the atoms. After six cycles of refinement, the R value reduced to $15 \cdot 6\%$ for a total of about 600 reflections. When unobserved reflections were omitted, the R value was $12 \cdot 4\%$.

4. MAIN FEATURES OF THE STRUCTURE

The co-ordinates of the atoms at the stage of the last refinement are given in Table I. A map

of the structure projected along the *c*-axis is shown in Fig. 1. The bond lengths and the bond angles are shown in Table II.
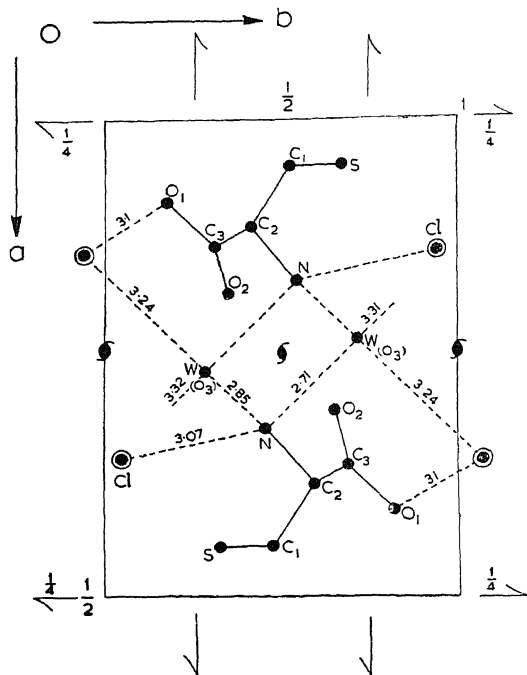
FIG. 1. Structure of L (+) Cysteine hydrochloride monohydrate projected down the *c*-axis. Hydrogen bonds are marked by dashed lines.

TABLE I

Atomic co-ordinates of L(+) cysteine hydrochloride monohydrate

(Origin as in *International Tables*, Vol. I)

| Atom | Atomic Co-ordinates | | | Temp. factor |
	x	y	z	B (Å^2)
Cl	0·3596	0·0520	0·0145	2·09
S	0·4513	0·3214	0·4344	2·63
O_1	0·4097	0·8195	0·4487	2·55
O_2	0·3122	0·6584	0·3891	3·08
O_3	0·2641	0·2362	0·4282	2·33
N	0·3269	0·4595	0·8024	1·19
C_1	0·4533	0·4786	0·6879	0·95
C_2	0·3869	0·5903	0·7363	1·01
C_3	0·3649	0·6916	0·5140	1·90

Table II shows that all the bond lengths and bond angles are normal within the accuracy of

TABLE II

Bond lengths and bond angles

S —C_1	1·795 Å	S —C_1—C_2	115° 34′
C_1—C_2	1·532 Å	C_1—C_2—C_3	111° 58′
C_2—C_3	1·494 Å	C_1—C_2—N	111° 48′
C_2—N	1·540 Å	C_2—C_3—O_1	111° 24′
C_3—O_1	1·319 Å	C_2—C_3—O_2	125° 59′
C_3—O_2	1·261 Å	O_1—C_3—O_2	122° 30′
		C_3—C_2—N	105° 20′

refinement reached so far. The system of hydrogen bonds may be seen in the figure. The hydrogen bonds are of the type O—H....Cl, N—H....Cl and N—H....O. The value of the bond lengths for C—O (1·26 and 1·32 Å) in the carboxyl group indicates that most probably the structure is of the non-zwitterion form and that one of the carboxyl oxygens exists in the O—H form. The hydrogen bonding around nitrogen is also normal and has tetrahedral arrangement. The structure is stabilised by a chain of hydrogen bonds formed by the water molecule with the neighbouring chlorine atoms and the amino-nitrogen. The surroundings of the water are nearly tetrahedral.

These features are under closer examination and a complete three-dimensional least square refinement is under progress.

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THE INHIBITORY EFFECT OF PUROMYCIN ON ADAPTATION OF GUINEA-PIG TO AEROSOLS OF ACETYLCHOLINE AND HISTAMINE

JUSTYNA M. WIŚNIEWSKA[*] AND J. S. KNYPL[**]

DEPENDING on a season male guinea-pig can be adapted to 1·5% acetylcholine (ACh) aerosol[1] within a week in September-October or within 2-3 weeks in summer.[2] Since adaptation to ACh is about three times stimulated by cysteine[3] and in blood of the adapted animals activity of acetylcholine acetylhydrolase (AChH) increases to 130–150% of the control value,[2] it was necessary to test whether the process of adaptation will be affected by puromycin (PMC), known as a specific inhibitor of protein synthesis[4] and the inhibitor of AChH synthesis in chick embryo tissues.[5]

Increment of tolerance to ACh during the adaptation is coupled with the parallel increment of tolerance to histamine (H) aerosols, and *vice versa*.[2] For that reason the effect of PMC on adaptation to H was also studied.

Experiments were carried out on coloured male guinea-pigs weighing 260–290 g. PMC was injected intraperitoneally 3-4 hours before the exposition either in aerosol of ACh or H. Adaptation to ACh was carried out as described previously.[6] The animals once a day were exposed in the aerosol produced by generator D-30 modified in this laboratory as a model D-30 a.[7] A period of time, in sec., passing between a moment of introduction of the animal into the expositional chamber to a moment of appearance of initial symptoms of the third phase of induced asthmatic-like attack,[8] *i.e.*, bradypnœa, was taken as a measure of the actual ACh-tolerance. Guinea-pig which survived in the atmosphere of aerosol for 20 min. was regarded as the adapted one.[6] Adaptation to 0·5% aerosol of H was carried out in the same manner. AChH activity in blood samples of the ACh-adapted animals was determined according to Hestrin's colorimetric method as modified by Augustinsson.[9] Control animals were adapted either to ACh or H without injections of PMC. Each experiment was repeated three times.

PMC in doses 500 or 1,000 μg./kg. body weight markedly inhibits both adaptation to ACh (Fig. 1) and H (Table I). Four to six days

after the last injection of PMC the symptoms of its action seemed to disappear, since subsequently the animals vigorously adapt as well
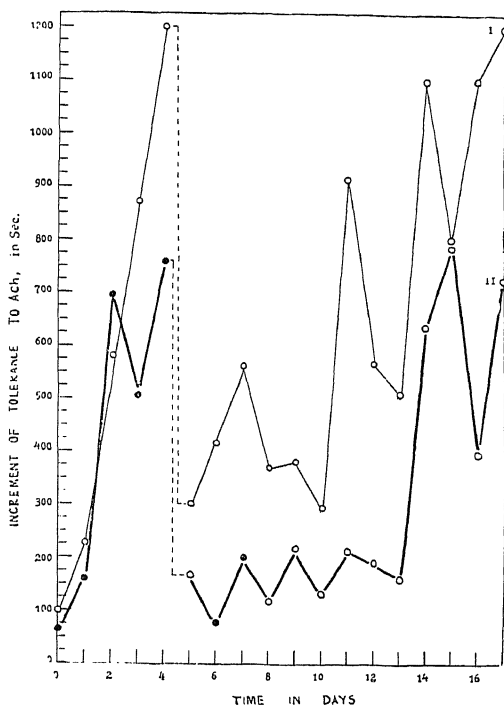
FIG. 1. The inhibitory effect of puromycin on adaptation of guinea pig to ACh. I, control; II, the animals injected seven times with PMC. Both groups I and II initially were exposed to 1·5% ACh (5 tests) and latter to 1·8% ACh; vertical dotted lines mark a moment of change of ACh concentration. Solid circles mean that PMC was injected 3-4 h before the exposition, initially in a dose of 500 μg. (kg. 5 times) and finally in a dose of 1,000 μg/.kg (2 times). The experiments were carried out in September.

to H as ACh. Determinations of AChH activity in the blood revealed that Q_{AChH} did not change after 11 days of adaptation to ACh of the animals systematically injected once a day with 250 or 350 μg./kg. PMC. On the contrary, in blood of the control animals, adapted to ACh without injections of PMC, Q_{AChH} increased from initial 198 to final 302 μM ACh/60 min./ml. (Table II).

TABLE I

The effect of puromycin on adaptation of guinea-pig to 0·5% aerosol of histamine

	Group	Time of adaptation, in days											
		1	2	3	4	5	6	7	8	9	10	11	12
Tolerance to H in sec. ..	C	85	208	299	347	470	613	709	744	908	690	1100	1200
Body weight, in g. ..	C	290	293	297	300	302	303	306	310	313	315	320	325
Tolerance to H in sec. ..	PMC	77	76	149	201	105	96	302	311	309	314	650	735
Body weight, in g. ..	PMC	297	295	296	298	302	305	313	316	319	323	329	331

Group C = Control ; group PMC = the animals were five times injected with PMC (1,000 μg./kg.) in 2-6 days of the experiment (the subsequent times of expositions are italicized). Each group contained 10 animals. These experiments were carried out in September.

TABLE II

The effect of puromycin on AChH activity in blood of guinea-pig adapted to 1·5% aerosol of ACh

Group	Number of animals	Tolerance to ACh, in sec.	$Q_{AChH} \pm$ S.D.
I	.. 3	79	198 ± 12·8
C	.. 12	900–1100	302 ± 10·6
PMC–250	.. 9	260	198 ± 9·5
PMC–350	.. 9	151	192 ± 10·1

I = intact animals; C = control animals adapted to ACh for 11 days; PMC–250 = 11th day of adaptation, before each exposition the animals were injected with 250 μg./kg. PMC; PMC–350 = 15th day of adaptation of the group previously noted as PMC–250, from 11th day the animals were injected with 350 μg./kg. PMC; $Q_{AChH} = \mu M$ ACh hydrolysed per hour per ml of blood; blood samples were withdrawn from a heart. Determinations were carried out in June-July.

It is worthy of note that in a series presented in Fig. 1, one of the animals which was injected with 1,000 μg./kg. PMC on 6th day of the experiment did not survive this dose of the inhibitor. It died 2·5 hours after the injection showing typical symptoms of the prolonged ACh intoxication, that is convulsions and white excretion in eyeballs, despite the fact that this guinea-pig was not exposed to the aerosol this day. Since in a brain of the ACh-adapted animals the level of ACh increases up to 200%,[2]

it may be supposed that this animal was intoxicated with endogenous ACh.

The data presented here indicate that (1) both adaptation to ACh and H is dependent on synthesis of protein (s), and (2) support the assumption that adaptation to ACh is dependent on ACh-induced synthesis of AChH.[2] The possibility that adaptation to H is also dependent on stimulated synthesis of AChH is now under a direct examination.

Many thanks are due to Dr. J. R. Tata of the National Institute for Medical Research, Mill Hill, London, for a gift of puromycin.

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INTERNAL CONVERSION PROCESS AND NUCLEAR STRUCTURE

AN International Conference on Internal Conversion Process was held at Nashville, Tennessee, in the U.S.A. from May 10-13. The Conference was jointly sponsored by the International Union of Pure and Applied Physics, the U.S. Atomic Energy Commission, the U.S. National Science Foundation and the Vanderbilt University, Nashville.

About 100 scientists from 16 countries participated in the Conference. Besides review papers on the basic theory of the process and experimental methods used for its study, some 60 contributed papers were presented.

In making a transition from one level to another, the nucleus can give up energy K, angular momentum L and parity π, in the form of a γ-ray or these can be transferred to one of the orbital electrons. The ejection of the electron occurs through interaction of the electron and nuclear currents and charges through the electromagnetic field. The internal conversion coefficient, which is the ratio of rates of ejection of electron and γ-ray, depends on the electron wave-function and K, L, π. Determination of these coefficients has been a powerful method of establishing the spins and parities of nuclear levels. These studies received a fresh impetus over the last decade, when Rose[1] and Sliv computed the effect of finite nuclear charge distribution on the Dirac wave-functions of the electron and on internal conversion coefficients. In the case of magnetic dipole transitions, experimental verification of such effects was soon obtained. In the case of pure electric quadrupole transitions in deformed nuclei, there has been interesting speculation on whether or not the I.C.C. are affected by nuclear deformation. Experimental evidence so far has been conflicting. It was reported[2] by the Bombay group that in the case of several deformed nuclei, the K-conversion coefficients for $2^+ \rightarrow 0^+$ transitions agree with the theoretical values of Rose and Sliv and that deformation parameter has no effect on I.C.C. At this Conference, P. Erman and S. Hultberg of Research Institute of Physics, Stockholm, reported similar result obtained by Internal-External Conversion method after applying proper corrections for scattering of low energy photo-electrons. This

was also supported in the case of Yb^{170}, by Jansen and Wapstra of Amsterdam. The present author reported to the Conference recent results on X-ray yields from K-ionization due to α-particle bombardment at 3 and 4 MeV, for several spherical and deformed nuclei, using the 5·5 MeV Van de Graaff accelerator at Trombay. Isotopically enriched Sm and Gd isotopes were used in these studies besides Sn, Te, Ce, W and Pb isotopes. It was found that there is no measurable excess in X-ray yield from deformed nuclei, as was reported several years ago by McGowan[3] and Stelson. This further corroborates the result that deformation has no effect on I.C.C. for pure E 2 transitions.

Some of the highlights of the Conference were (1) a review on conversion electron-gamma directional correlations by Professor T. R. Gerholm, Stockholm, (2) a talk on the use of semiconductor detectors for I.C.C. measurements by Professor J. M. Hollander, Berkeley, California, (3) a talk on spectroscopic measurements currently needed for nuclear models by Professor L. S. Kisslinger, Cleveland, Ohio.

On the last day of the Conference, there was a panel discussion on internal conversion coefficients; the four members of the panel being Professor M. E. Rose, University of Virginia, U.S.A., Professor Thosar, Dr. W. H. G. Lewin, Delft, Netherlands and Professor J. H. Hamilton, Vanderbilt University. The consensus was that more accurate experimental data are needed on various aspects of internal conversion process in relation to nuclear structure.

Professor J. O. Rasmussen, Berkeley, California, gave a summary of the Conference proceedings at the end. The proceedings of the Conference are expected to be published by the end of the year.

Tata Institute of   B. V. THOSAR.
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LETTERS TO THE EDITOR

ON ROSEN-DESIRANT ULTRA-VIOLET BANDS OF SULPHUR

IN a high-frequency discharge through sulphur vapour, Rosen and Desirant[1] reported two groups of bands designated by them as A and B in the region 2448–2660 Å and 2707–2846 Å respectively. These bands have recently been obtained in a microwave discharge[2] through sulphur vapour. Rotational analysis[3] of six of these bands (2620, 2660, 2760, 2793, 2813 and 2847 Å) proved that bands of both the groups together form a system involving the transition $^1\Delta_u - {}^1\Delta_g$. The same result has been arrived at independently by Ketteringham and Barrow[4] by a rotational analysis of three of these bands (2847, 2793 and 2760 Å). Studies of spectra obtained with 44·4% enriched ^{34}S isotope enabled a unique assignment of vibrational quantum numbers to the bands and established the emitter to be the S_2 molecule.[5] These studies show that the vibrational quantum numbers assigned by Ketteringham and Barrow have to be changed from 0–2, 0–1, and 1–1 to 1–3, 1–2 and 2–2 respectively.

In the discharge through natural sulphur, three more bands at 2449, 2472 and 2495 Å were recorded. These were found to fit well into the $^1\Delta_u - {}^1\Delta_g$ system as the 10–0, 9–0 and 8–0 bands respectively.[2,3] In order to check this assignment, spectra with 37·2% enriched ^{34}S have been taken. These spectra contain bands due to $^{32}S\,^{34}S$, $^{32}S_2$ and $^{34}S_2$, the intensities of the bands decreasing in that order. These are shown in Fig. 1 (b) which also contains in juxtaposition the spectrum obtained with natural sulphur. Isotopic shifts of bands of $^{32}S\,^{34}S$ with respect to the corresponding bands of $^{32}S_2$ at 2448·6 Å and 2471·8 Å are found to be 54 cm.[-1] and 49 cm.[-1] respectively which agree well with the calculated shifts of 53·6 cm.[-1] and 48·8 cm.[-1] for the corresponding 10–0 and 9–0 bands and confirm the vibrational assignment of the bands proposed earlier.

Another interesting feature of this band system noticed for the first time in these experiments is that the system breaks off suddenly after $v' = 10$, there being no trace of 11–0 band at its expected position. This can be seen in Fig. 1 (a) and indicates predissociation of the molecule. It may be recalled that a similar situation occurs in the main band system $^3\Sigma_u^- - {}^3\Sigma_g^-$ of S_2 where the breaking off occurs after $v' = 9$.

Spectroscopy Division,   N. A. NARASIMHAM.
Atomic Energy   KUM. SHEILA GOPAL.
    Establishment,
Trombay, Bombay-28, *May* 29, 1965.

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DIELECTRIC CONSTANTS OF 2-METHOXY 4-NITRO ANILINE AND 2-METHOXY 5-NITRO ANILINE

2-Methoxy 4-nitro and 5-nitro anilines are solids at room temperature. An experimental method[*] is developed for the determination of the dielectric constants of such solid substances in the 3 cm. wavelength region using a variable

where ε is the observed apparent dielectric constant, ε_0 is the dielectric constant of the massive solid and δ is the packing fraction given by the ratio, volume occupied by powder/volume of the cavity of the cell.

Table I gives the values of ε and δ and of 'ε_0' of the two substances using the two formulæ separately.

TABLE I

Dielectric constant data (Temp. 28° C.)

Substance	Packing fraction δ	Apparent Dielectric constant ε	ε_0 from Bottcher's formula	ε_0 from Bruggmen's formula	ε_0 from graph
2-methoxy 4-nitro-aniline	0·3686	1·762	3·91	4·21	
	0·4420	1·990	3·99	4·32	3·91
	0·5086	2·152	3·87	4·15	
			Av. 3·92		
2-methoxy 5-nitro-aniline	0·2780	1·647	4·01	4·32	
	0·2997	1·584	3·90	4·18	4·01
	0·3436	1·700	3·93	4·23	
	0·4256	1·970	4·04	4·47	
			Av. 3·97		

Holn cavity resonator. The microwave assembly consists of the usual reflex Klystron with a stabilised power supply, a matching unit, a power monitor, the resonator, a second matching unit on the detector side and a crystal detector. Besides the other components, the resonator is specially constructed out of an X-band cylindrical waveguide of length 12·5 cm. sufficient to record up to the fourth and fifth consecutive resonances. The specimen, in the form of a compressed disc, is contained in a thin-walled recess machined out of the tight fitting but removable piston at the bottom of the resonator and the recess constitutes the dielectric cell.

Observations are obtained for the two substances which are available in the form of amorphous powders. The dielectric constant data reported here are new. Experiments have been conducted with different packing fractions of the powders and the apparent dielectric constants are evaluated by the method described by Horner, Taylor, Dunsmuir, Lamb and Jackson.[1] The value corresponding to the massive solid has been deduced from the powder data making use of the formulæ suggested by Bottcher and by Bruggmen.[2]

$$\frac{\varepsilon - 1}{3\varepsilon} = \frac{\delta(\varepsilon_0 - 1)}{\varepsilon_0 + 2\varepsilon} \text{ — Bottcher's formula}$$

$$\frac{\varepsilon_0 - \varepsilon}{\varepsilon_0 - 1} = (1 - \delta) \sqrt[3]{\varepsilon} \text{ — Bruggmen's formula}$$

The values of ε_0 are also found from graphs plotted with ε *versus* δ. The last column in the table gives the value of ε_0, read from the graph for $\delta = 1$ corresponding obviously to that of the massive solid. The value agrees better with the values derived from the Bottcher's formula than with the Bruggmen's formula.

The author is indebted to Prof. K. R. Rao for his guidance and to the Government of India for the award of a Research Fellowship.

Microwave Lab.,   K. S. Ramakrishna Rao.
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Waltair, *March* 31, 1965.

* T. Sen collaborated with the author in setting up this arrangement.

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o-NITROCINNAMALDEHYDE CONDENSATIONS: FORMATION OF SOME OXAZOLONES

In a previous letter[1] the condensation of o-nitrocinnamaldehyde with certain malonic acid derivatives has been reported. Recently Acheson *et al.*[2] studied the use of p-dimethyl amino-benzaldehyde and p-dimethyl amino-

TABLE I

S. No.	Name	Formula	m.p. °C.	Yield %	Nitrogen %	
					Found	Required
1	2-Styryl-4-R	$C_{20}H_{14}O_4N_2$	220	60	7·18	7·2
2	2-(3:5 dinitrophenyl)-4-R	$C_{18}H_{10}O_8N_4$	242	38	13·35	13·65
3	2-(p-Nitrophenyl)-4-R	$C_{18}H_{11}O_6N_3$	257	80	11·44	11·5
4	2-(o-Nitrophenyl)-4-R	$C_{18}H_{11}O_6N_3$	248	22	11·44	11·5
5	2-(m-Nitrophenyl)-4-R	$C_{18}H_{11}O_6N_3$	199	67	11·36	11·5
6	2-(p-chlorophenyl)-4-R	$C_{18}H_{11}O_4N_2Cl$	220	79	7·81	7·89
7	2-(o-chlorophenyl)-4-R	$C_{18}H_{11}O_4N_2Cl$	218	18	7·06	7·89
8	2 Phenyl 4 R	$C_{18}H_{12}O_4N_2$	201	88	8·47	8·7
9	2-(3 : Methylene dioxyphenyl)-4-R	$C_{19}H_{12}O_6N_2$	204	55	7·52	7·69
10	2-(p-Methoxyphenyl)-4 R	$C_{19}H_{14}O_5N_2$	167	76	8·3	8·0
11	2 Benzyl 4-R	$C_{19}H_{14}O_4N_2$	126	35	7·99	8·38

R—Stands for *o*-nitrocinnamal-5-oxozolone.

cinnamaldehyde as reagents for the chromatographic detection of acyl glycines.

The present communication deals with the condensation of o-nitrocinnamaldehyde with some acyl glycines, and the formation of the corresponding oxazolones. The acyl glycines selected were :

Cinnamoyl, benzoyl, o-, m-, and p-nitrobenzoyl, 3 : 5 dinitrobenzoyl, o-, p- chlorobenzoyl, piperonly, p-methoxy benzoyl and phenacyl glycine. These were prepared by well-known methods described in literature. The general method followed for preparing the oxazolones is illustrated by the following example.

A mixture of o-nitrocinnamaldehyde (·88 gr.), hippuric acid (·9 gr.), fused sodium acetate (·4 gr.) and acetic anhydride (1·5 gr.) was heated on a steam bath for three hours. After cooling, ethanol (5 ml.) was added and the flask was kept in ice for some time. The solid product was recrystallised from acetone or ethyl acetate. Yellow needles of 2-phenyl-4-o-nitrocinnamal-5-oxazolone (·14 gr.), m.p. 201° were obtained.

The oxazolones prepared ranged from yellow to orange in colour and their yields varied from 18-88%. The analytical results, m.p., etc., of these oxazolones are given in Table I.

Department of Chemistry,   O. P. SINGHAL.
St. John's College, Agra,   P. I. ITTYERAH.
April 15, 1965.

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SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH 7, 8, 3′, 4′-TETRAHYDROXY FLAVONOL

ZIRCONIUM is known to form stable chelates with 3-hydroxy flavones.[1] Complexes formed by zirconium with flavonol,[2] morin,[3] quercetin,[4] galangin[5] and robinetin[6] have been investigated earlier and made use of in the micro-determination of zirconium. In the present communication the use of 7, 8, 3′, 4′-tetra-hydroxy flavonol is described in the spectrophotometric determination of zirconium.

The compound was isolated from a natural source (private communication from K. K. Malik). Its standard solution was prepared in alcohol. Standard solution of zirconium was prepared by dissolving $ZrOCl_2.8H_2O$ (AR) in double distilled water in presence of hydrochloric acid. Absorbance readings were taken with a Unicam SP 600 spectrophotometer.

Solutions were prepared containing zirconium and the flavonol in different molar ratios (1·0 : 0·25 to 1·0 : 4·0) and in varying HCl concentrations (0·05 N to 4·0 N). They were diluted to 10·0 ml. keeping 40% alcoholic medium to avoid possible precipitation of the reagent. Absorption spectra of these solutions were taken using reagent blanks. In all cases λ_{max} has been found to lie at 415 mμ.

The optical density of the reagent remains practically constant between 0·05 N and 1·5 N HCl concentrations when measured at 415 mμ. Beyond this acidity the reagent shows significant rise in optical density. The intensity of the complex shows little change between the concentrations 0·2 N and 4·0 N HCl. As the absorption due to the reagent blanks starts increasing beyond 1·5 N HCl concentration in the solutions, the foregoing studies have been done below 1·5 N HCl.

The complex has been found to obey Beer's Law from 0 to 3 p.p.m. of zirconium in 1 N HCl concentration. Sensitivity of the reaction has been found to be 0·003 μg. Zr/cm.$^2 \equiv \log I_0/I = 0·001$. Average value of stability constant of the complex with metal ligand ratio as 1 : 1 has been calculated to be $3·65 \times 10^5$ in 1 N HCl concentration (20° C.).

The molar composition of the complex has been ascertained by the method of continuous variations. Under all the varied HCl concentrations the complex has been found to contain zirconium and the ligand in 1 : 1 stoichiometric ratio. Some of the representative curves are shown in Fig. 1. A structure similar to zir-
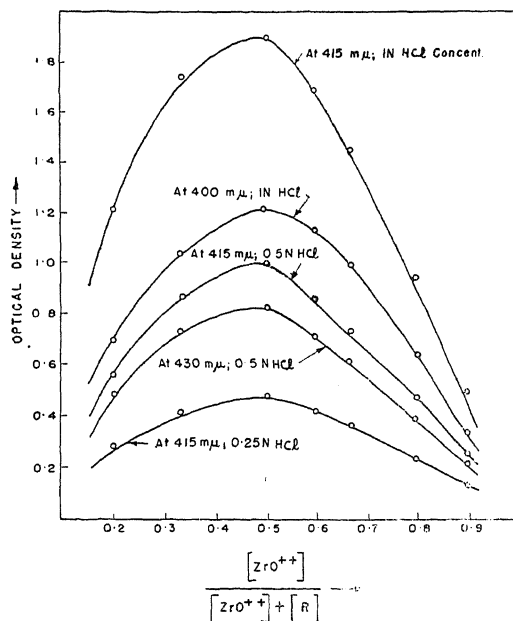
Fig. 1. Determination of composition of the complex by the method of continuous variations.

conium-quercetin complex[4] may be proposed for the complex (I).

(1)
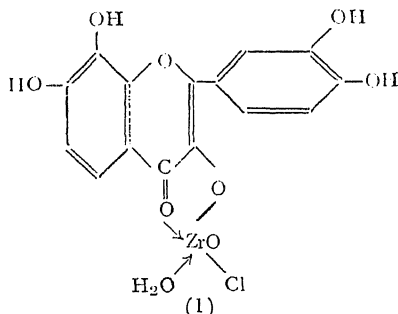
When alcoholic solution of the reagent was added to different salt solutions, yellow-coloured complexes were formed in a number of cases,

viz., with copper, molybdate, thorium and rare earths. With thorium it reacts in 1 : 1 molar ratio while with rare earths different complexes are formed. It has been found that with neodymium it forms two complexes at pH 6·0 having the ratios Nd : reagent = 1 and 2 while dominating complex in case of *lanthanum* has the composition 1 : 2 (La : reagent) at pH 6·5. The effect of diverse ions in determination of zirconium has been investigated in 1 N HCl medium in which the selectivity of the reagent is greatly improved. The results are embodied in Table I.

TABLE I

Effect of foreign ions in determination of Zirconium

(Zr taken 1·80 γ)

Foreign ion added		Amount added (in p.p.m.)	Zr found (in γ)
Cd^{+2}	..	125	1·80
Pb^{+2}	..	200	1·80
Co^{+2}	..	60	1·80
Cu^{+2}	..	64	1·57
Zn^{+2}	..	65	2·00
Ni^{+2}	..	60	1·78
Be^{+2}	..	90	1·50
UO$_2^{+2}$	..	150; 300	1·80 ; 1·77
In^{+3}	..	100	1·80
La^{+3}	..	100	1·80
Th^{+4}	..	2	1·80
Ce^{+4}	..	64	1·59
NO$_3^{-}$	..	1590	1·80
CH$_3$COO^{-}	..	1380	1·80
CNS^{-}	..	150	1·80
B$_4$O$_7^{--}$	..	185	1·80
S$_2$O$_3^{--}$	..	70	1·96
Tartrate	..	115	1·72
Citrate	..	205	1·55
F^{-}, IO$_3^{-}$ MoO$_4^{--}$ & PO$_4^{---}$		Traces	Interfere

Department of Chemistry,   Mohan Katyal.
University of Delhi,   B. P. Gupta.
Delhi-7, *April* 26, 1965.   R. P. Singh.

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STUDIES ON THE OXALIC ACID SYNTHESIS BY *SCLEROTIUM ROLFSII*, SACC.

NUMBER of fungi are known to produce oxalic acid.[1] Earlier studies on *Sclerotium rolfsii* Sacc., the causal organism of root rot of many host plants, have shown this fungus to be a potent synthesizer of oxalic acid.[2] With a view to obtain the optimum conditions for oxalic acid synthesis, the influence of certain media on the production of the acid, the partition of the acid between the mycelium and the culture filtrate and the interrelationship of growth to the acid synthesis, have been studied and the results are reported in this communication.

An isolate of *Sclerotium rolfsii* from diseased bean plant, *Phaseolus vulgaris,* maintained on potato glucose agar, was grown on various solid and liquid media, prepared according to standard formulæ.[3] A single *sclerotium* was always used as the standard inoculum. The pH of the media was adjusted to 6·0, the optimum for the growth of the fungus. The growth rate on solid media was determined by the diameter of the colony and on liquid media by the dry weight of the mycelium. Oxalic acid in the culture filtrate was estimated by $KMnO_4$ titration method.[4] Estimation of oxalic acid in the mycelium was done as follows: The mycelium was ground with acid washed powdered glass and the oxalic acid extracted with 75 ml. of distilled water. The solution was allowed to stand for one hour at room temperature and centrifuged at 9,000 R.P.M. for 15 minutes. The clear supernatant was used for determining the oxalic acid.

The complex organic media used and their effect on mycelial growth are shown in Table I.

TABLE I

Effect of different solid media on growth of Sclerotium rolfsii*

Medium	Radial growth in mm. after			
	2 days	3 days	4 days	5 days	6 days
Oat-meal agar	14·0	36·5	59·0	85·0	covered the plate (90 mm,)
Potato glucose agar	38·9	covered the plate	..	..	.. *
Bean extract agar	23·3	56·3	82·7	covered the plate	..
Carrot extract agar	15·0	73·7	87·3	do.	..

* Average of three replicates.

Since the isolate was from a bean plant, bean agar media was also included in the study.

Maximum growth was observed after 3 days in potato glucose agar followed in order by carrot extract agar, bean extract agar and oat-meal agar.

The mycelial yield and oxalic acid production after 20 days incubation at room temperature in different liquid media are shown in Table II.

TABLE II

Mycelial yield and oxalic acid production by S. rolfsii

Medium	pH of the culture filtrate	Dry weight of the mycelium in mgm.	Oxalic acid in the culture filtrate expressed in mg.	Oxalic acid in the culture filtrate expressed in mg. produced per gm. dry weight of the mycelium
Czapek's solution	5·7	360	2·5	6·94
Richard's solution	4·4	400	32·7	81·8
Asparagin glucose solution	4·6	270	12·6	46·7
Glucose-peptone solution	3·1	700	247·6	353·7

Glucose peptone medium was found to be the best both for the growth of the fungus and the synthesis of oxalic acid. This was selected for further studies relating to the production and distribution of oxalic acid between the mycelia and culture filtrate, during the growth of the fungus. The results are presented in Table III.

TABLE III

Mycelial growth and oxalic acid synthesis by S. rolfsii

Days of incubation	pH of the culture filtrate	Dry weight of the mycelium in mg.	Oxalic acid in the culture filtrate expressed in mg.	Oxalic acid in the mycelium expressed in mg.
4	5·7	10	8·4	..
6	3·2	364	210·0	6·4
8	1·9	1168	319·2	12·6
10	2·3	1167	260·4	12·6
12	2·5	868	244	12·6
16	2·8	708	228	9·6
20	3·2	676	236	6·4
24	3·9	516	296	6·4
28	4·0	412	286	6·4
32	4·1	376	276	3·2

It is seen that the maximum growth of the fungus on glucose peptone medium is reached in about 8-10 days after which time the phase of autolysis sets in. With this onset of autolysis, as indicated by the diminished mycelial mat, there is a corresponding reduction in the oxalic

acid content of the culture filtrate and the mycelium.

The major portion of the oxalic acid synthesized diffuses out into the media and only a small amount of oxalic acid is retained in the mycelium. The metabolic fate of the oxalic acid with the onset of autolysis and the factors involved in the alterations observed in the pH of the media need elucidation.

Pharmacology Laboratory,   JOSEPH BAGYARAJ.
Indian Inst. of Science,   M. SIRSI.
Bangalore-12, *March 31, 1965.*

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PALMOXYLON SCOTTII : REVISED NAME FOR *PALMOXYLON SAHNII* MENON

IN 1933, Rode[2] described a new species of petrified palm stems from the Deccan Intertrappean beds of Mohgaonkalan and named it as *Palmoxylon sahnii*. This was later shown to belong to the family Cyclanthaceæ and was referred to a new genus *Cyclanthodendron* as *Cyclanthodendron sahnii* (Rode) Sahni and Surange (1944).[3]

Recently one of us, Menon[1] (1964) described another palm wood from the same locality and designated it *Palmoxylon sahnii*. This was done under the impression that *P. sahnii* Rode having lapsed into synonymy was no longer valid, particularly as the species has been referred to a new genus. But it is now realized that there is always the possibility of little confusion in the literature, more so if the original name by Rode is revived for some reason or other. In view of this it was thought best that the specimen should be given a new specific name. It is therefore hereby proposed that the specimen, described as *Palmoxylon sahnii* Menon (1964), be henceforth known as *Palmoxylon scottii* nom. nov. The specific name is after D. H. Scott, the great palæobotanist, who has inspired several generations of students for the study of petrified plant fossils.

For ready reference the diagnosis of the species is reproduced below under the new name :

Palmoxylon scottii (MENON) NOM. NOV.

Cortex present, with fibrous bundles and compact ground tissue. *Dermal zone*—Fibrovascular bundles regularly orientated ; 245–320 per cm.[2]; mostly elongated in form ; diameter 0·2–0·5 mm. ; f/v ratio 0·5/1–1·4/1 ; median sinus concave and auricular lobes rounded ; xylem vessels usually one, sometimes two or a group of vessels together. Stegmata, fibrous bundles, radiating and tabular parenchyma absent. Ground tissue compact with thin-walled parenchyma cells. *Sub-dermal zone*—Bundles more or less regular ; 150–170 per cm.[2]; f/v ratio 0·4/1–1/1 ; bundles with different sizes and shapes ; diameter 0·3–0·6 mm. Median sinus concave to flat and auricular lobes round ; metaxylem vessels usually two ; excluded, sometimes a number of xylem vessels grouped together ; protoxylem present ; no fibrous bundles, stegmata, radiating or tabular parenchyma and posterior sclerenchyma. Leaf-trace bundles bigger in size, fused bundles present. Ground parenchyma compact with thin-walled round to oval cells. *Central zone*—Irregularly orientated bundles ; 80–125 per cm.[2]; different sizes and shapes ; f/v ratio 0·3/1–0·8/1 ; diameter 0·5–0·8 mm. Median sinus concave to flat, auricular lobes round, metaxylem vessels mostly two, protoxylem present ; phloem preserved. Stegmata and fibrous bundles absent. Leaf-trace bundles seen clearly. Ground parenchyma same as in the dermal and sub-dermal zones.

Our sincere thanks are due to Dr. R. N. Lakhanpal for his criticism and advice.

Birbal Sahni Institute of   R. DAYAL.
Palæobotany, Lucknow,
      and
Department of Botany,   V. K. MENON.
Lucknow University
Lucknow (India), *January 22, 1965.*

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MICROFLORA FROM THE *DICROIDIUM*-BEARING BEDS OF SIDHI DISTRICT, MADHYA PRADESH *

THE note embodies the results of palynological study of the samples recovered from the *Dicroidium*-bearing beds recently reported from the Sidhi District, Madhya Pradesh.[1] The record of the microflora from these beds is of considerable interest as no microflora is

known from the Triassic beds of the Gondwana formations of Peninsular India.

A few samples having carbonised remains of *Dicroidium* were macerated in which a large number of spores were recovered. The assemblage comprises pteridophytic spores, gymnospermic pollen grains with some tracheids and woody fragments.
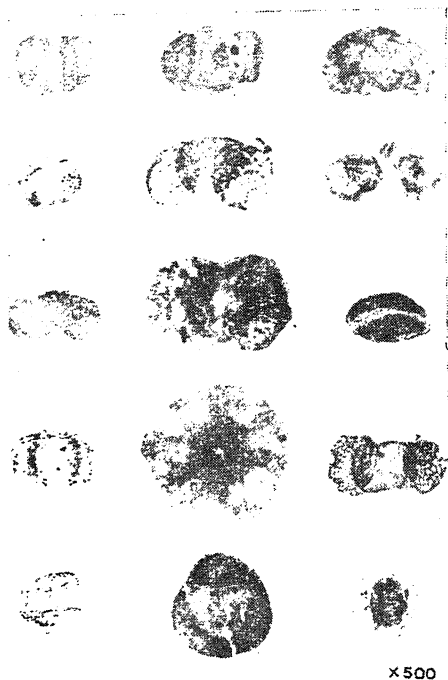
FIG. 1, Spores and pollen from the *Dicroidium* bearing beds of Sidhi District, Madhya Pradesh.

It has been observed that the assemblage consists mainly of bi-winged gymnospermous pollen with no striations on the body. These pollen are comparatively smaller in size than those recorded from the Raniganj stage (Upper Permian). In addition, tri-winged conifer pollen grains are also noted. The pteridophytic spores are very rare but the genus *Apiculatisporites* is, however, represented. The presence of pteridophytic spores having ribs or striations belonging probably to *Schizaeceae* are common.

Our present knowledge regarding the microflora of Trias in India is very meagre. Sitholey[2] described a number of saccate and trilete spores from the Triassics of Salt Range. Lakhanpal[3] and his collaborators recorded saccate and trilete spores, cuticles and fragments of wood from carbonaceous shales from Krols. Ghosh and Srivastava[4] described from Krols a few kidney-shaped spores resembling

the present-day spores of *Polypodiaceae* as well as pteridophytic spores referable to *Schizaeaceae* and bi-winged and tri-winged conifer pollen grains. According to the latter authors "Scanty yields of fossils which are identified as pteridophytic spores and a few coniferous pollen grains lead to the conclusion that Krols belong to the Triassic age". Hennelly[5] has described some triletes and bi-winged gymnospermous pollen from the Permo-Triassic transition of New South Wales, Australia, which has close resemblance to the present material.

Considering the assemblages on the whole, it is inferred that the trilete spores which were well represented during the Upper Permian (Raniganj) times became insignificant later and new forms like the ribbed or striated spores (probable *Schizaeceae*) gradually became common. The microflora supports a Triassic age to the formations as suggested by the *Dicroidium* flora.

The authors are thankful to Shri M. V. A. Sastry, for helpful suggestions.

Central Palaeontological Labs.,   A. CHANDRA.
Geological Survey of India,   P. P. SATSANGI.
Calcutta, *January* 19, 1965.

*Published with the kind permission of the Director-General, Geological Survey of India.

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EFFECT OF INSULIN ON THE FREE AMINO-ACIDS OF BLOOD AND FOOT OF *MERETRIX CASTA* (CHEMNITZ)

IN a previous publication,[1] the effect of insulin on the amino-nitrogen content of free amino-acids in the blood and foot of *Meretrix casta* (Chemnitz) was recorded.

The present paper deals with the effect of insulin on the actual pattern of free amino-acids of blood and foot of *Meretrix casta*.

Specimens of *Meretrix casta* were collected from the tidal zone of vellar estuary and kept alive in laboratory aquaria. Specimens of more or less equal weight and size were selected for experimental studies. Some of them were used as normal and the rest subjected to insulin treatment.

Standard doses of 1 unit of insulin/5 gm. body weight were injected and the free amino-

acid composition was determined in the foot and blood of the organism. The blood sample was pooled from 5 specimens of more or less same weight and for each estimation 1 c.c. of blood was employed. For foot also, a similar procedure was adopted and for each experiment 2 gm. of foot tissue was used.

The free amino-acid extracts were prepared in 80% alcohol in the usual manner. The amino-acids were identified by circular, ascending and two-dimensional paper chromatography using different solvent systems Whatman filter-paper No. 1 and 0·5% ninhydrin in acetone for the development of colour. The results are shown in Table I.

TABLE I

Effect of insulin on the free amino-acids of foot and blood of Meretrix casta

Amino acid	Foot		Blood	
	Normal	Experi-mental	Normal	Experi-mental
Leucines	—	Trace	—	—
Phenylalanine	—	do.	—	—
Valine, Methionine	—	—	—	—
Tyrosine	—	—	—	—
Proline	—	—	—	—
Alanine	+	+	+	+
Glutamic acid	+	+	+	+
Threonine	+	+	—	—
Glycine	+	+	+	+
Serine	+	+	+	+
Aspartic acid	+	+	+	+
Arginine	+	+	+	+
Histidine	+	—	+	+
Lysine	—	+	+	—
Cystine	+	+	+	+

The results show that in the normal foot, 9 amino-acids are present amongst which alanine, glutamic acid and aspartic acid are in higher concentration than others. Insulin injection leads to an increase in the number of free amino-acids as leucines, phenylalanine and lysine appear in the experimental clams. This is in agreement with the finding of Kasinathan and Vijayaraghavan[1] that insulin treatment increases the amino-nitrogen content of free amino-acids of the foot of *Meretrix*. However, insulin treatment causes a disappearance of histidine in the foot.

In the blood of normal animals, there are 9 free amino-acids. Presence of lysine in the blood of normal clams and its absence in the foot deserves special mention. Insulin injection results in a reduction of the number of free amino-acids in the blood as lysine disappears in the insulin-treated clams.

Insulin treatment thus seems to bring about a mobilisation of lysine from blood to foot. This will facilitate utilisation of lysine in the process of protein anabolism.

February 22, 1965. S. KASINATHAN.*

* Present Address: Department of Biology, Dhanvantari Medical College, Pondicherry.

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THE INHIBITORY EFFECT OF JAPANESE ENCEPHALITIS AND KYASANUR FOREST DISEASE VIRUSES UPON TUMOUR PRODUCTION BY *ROUS SARCOMA* VIRUS

OKER-BLOM and Strandstrom (1956) reported the blocking effect of inoculations of Coxsackie A10 virus, an enterovirus, on the production of tumours in chickens by *Rous sarcoma* virus.

Shirodkar (1963) described a similar effect of West Nile virus, an arthropod-borne virus. The present communication describes the inhibitory effect upon tumour production by two other arbo-viruses, viz., Japanese encephalitis (JE) and Kyasanur Forest disease (KFD) viruses, which are serologically related to the West Nile virus.

JE virus (P 20778 strain, isolated from a human case in Vellore, Madras State, and in its seventh mouse passage) and KFD virus (P 9605 strain, isolated also from a human case in Sagar, Mysore State, and in its tenth mouse passage) were obtained as infected mouse brain suspensions in phosphate buffered saline containing 0·75% bovalbumin (BAPS). White leghorn chickens (6-8 days old) were inoculated into the wing webs with 0·05 ml. of JE and KFD virus suspensions, containing respectively $10^{4·8}$ and $10^{5·8}$ $LD_{50}/0·05$ ml. for adult Swiss albino mice by the intracerebral route. Control groups of chickens were inoculated with plain BAPS. Twenty-four to forty-eight hours later all the chickens were inoculated with 0·05 ml. of Rous virus suspension containing $10^{4·0}$ pock-forming units in chorio-allantoic membrane per 0·05 ml. prepared in 0·05 m. sodium citrate by the method of Bang and Foard (1963). The chickens were

TABLE I

Production of tumour by Rous sarcoma *virus in chickens with and without pre-inoculation with arbo-viruses*

Arbo-viruses and doses	Interval between inoculation of the two viruses (hrs.)	Dose of RSV	Days after RSV inoculation							
			7 days		10 days		14 days		21 days	
			Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
JBE 4·8*	24	4·0†	7‡/30	22/24	9/30	24/24	15/30	24/24	..	..
KFD 5·8	48	4·0	..	..	3/22	15/26	10/22	18/22	8/20	22/22
					10/27					
JBE 4·8	24	4·0	..	..	10/38	27/30	..	..	..	..
KFD 5·8	24	4·0	..	..	14/32	27/30	19/30	27/28·	..	..

* Log LD_{50}/·05 ml. adult mouse.   † Log pock forming units/0·05 ml. CAM.

‡ Numerator/Denominator = Nos. of tumour positive wings/Nos. of wings inoculated.

observed for the development of tumours in the wing webs. The size of a tumour was assessed from the proportion of the wing web it covered.

Table I shows that tumour formation occurred in a proportion of the wings inoculated with JBE and KFD viruses ranging in different experiments from 10 out of 22 to 15 out of 30 wings, whereas in the control groups the tumour formation occurred in 18 out of 22 to 24 out of 24 wings on the 14th day. It was also observed that the sizes of tumours developing in the chickens previously inoculated with the arbo-viruses were much smaller than in the control groups at the same time. The mechanism of such a blockade has not been worked out yet.

Virus Research Centre,   K. BANERJEE.
Poona,** *April* 9, 1965.

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2. Oker-Bloni, N. and Strandstrom, H., *Ann. Med. Exp. Fenn.*, 1956, **34**, 301.
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A NEW BACTERIAL LEAF-SPOT ON VITIS TRIFOLIA

Vitis trifolia is a very widely distributed creeper growing throughout India, Ceylon and Malacca. A bacterial disease affecting the leaves has been noticed on plants growing on the grounds of Garda College, Navsari, during September, 1961.

The pathogen on *Vitis trifolia* produces round to irregular spots, 0·5 to 1·5 mm. with dark to brown centre and halo of 0·2 to 0·5 mm. Spots when numerous and close together coalesce, crack and drop off. When held against light, a clear halo around the infected spot is always noticeable. The tips of the crenate margins seem to be infected first probably through hydathodes. Vein infection extending up to about 1 to 1·5 mm. is common. Petioles are also susceptible. Swelling appears on stems. In some cases, twisting of leaves is also observed.

Isolations from young, pale brown lesions by usual poured plate method yielded pure, yellow-pigmented, smooth, raised and shining colonies after an incubation period of 48–72 hours at room temperature (28° C). The culture was then tried for its pathogenicity on *Vitis trifolia* and other plants by atomising the water suspension of a 48-hr. old culture grown on potato dextrose agar slants and subsequently placing the plants under moist chamber for 24 hrs. before removing them to the benches. After the appearance of typical symptoms as observed under natural conditions, re-isolations were made. The organism thus obtained was identical to the previously isolated one in respect of morphological, biochemical and other characteristics. The pathogen does not infect 8 species of Leguminosæ, 5 species of Tilliaceæ, *Alangium lamarckii* Thw., *Ionidium heterophyllum* Vent., *Vitis carnosa* and *V. woodrowii* Stapf. Some differences in cultural and biochemical reactions also exist between *Erwinia vitivora*, *X. vitis-woodrowii* Patel and Kulk., *X. vitis carnosæ*

Moniz and Patel and the one under report here. It is, therefore, proposed to name the pathogen, *Xanthomonas vitis-trifoliæ* as nov. sp. whose description is as follows:

Short rods with rounded ends, usually single with a polar flagellum, gram-negative, non-spore-forming, capsulated; colonies on potato dextrose agar are circular, glistening, smooth, convex; gelatin liquefied, starch hydrolysed, casein digested, milk peptonised and litmus reduced; no nitrite production from nitrate, indole not produced; hydrogen sulphide and ammonia produced from peptone; V.P. and M.R. tests negative; citrate utilised but not uric acid; acid but no gas from glucose, sucrose and maltose; no growth in salicin and 3% NaCl; strict aerobe; optimum temperature for growth 27°–30° C., thermal death-point 52° C.; of the 18 amino-acids tried, Glycine, DL-Serine, DL-nor Leucine and Tyrosine were not utilised as a sole source of N whereas fair to good growth was obtained only in DL-Alanine, L-Glutamic acid, DL-Proline and L-Hydroxy-Proline when used as a sole source of C. Producing leaf-spots on *Vitis trifolia* only. Found at Navsari, Gujarat State.

Microbiology Dept., A. C. PADHYA.
Baria Science Institute, M. K. PATEL.
 Navsari, Gujarat State, W. V. KOTASTHANE.
January 13, 1965.

A NOTE ON THE OCCURRENCE OF BASAL MERISTEM IN THE OVULES OF *CABOMBA CAROLINIANA* GRAY.

THE morphology of the ovules in angiosperms has been described in numerous papers dealing with the embryology of specific taxa. The conclusions that could be drawn from these publications is that the ovules could be classified under one of the following classes: orthotropous, anatropous and campylotropous. The other facts recorded so far relate to the number of integuments—one, two or three, presence of aril and obturator. Much of this elementary information was available in the last century and no advance appears to have been made since then. For instance, little information is available on the developmental aspects of ovules particularly from a morphogenetic view-point. A study of the ovules of *Cabomba caroliniana* from this point of view revealed the presence of a characteristic meristem in the nucellus.

The details of ovule development in *Cabomba caroliniana* have been described elsewhere (Ramji and Padmanabhan, 1965). The ovule primordium arises as a finger-shaped projection and undergoes a curvature of about 180° to become anatropous. By this time the integuments are already initiated and the megaspore mother cell and parietal cells are formed. The megaspore mother cell is separated from the chalaza by a narrow zone of cells (Fig. 1). This zone is the seat of origin of the meristem which causes the heightening of the nucellus. We designate this meristem as the 'basal meristem' due to its location at the base of the nucellus.

Numerous cells in division are evident in the basal meristem by the time the megaspore mother cell undergoes division (Fig. 2). After dyad formation, the activity of the basal meristem is accelerated and several vertical files of squarish cells are produced (Fig. 3). The height of the nucellus is doubled by the time the dyads are formed (cf. Figs. 1 and 2). An increase in height by four times is evident when the upper dyad degenerates (cf. Figs. 1 and 3). The maximum height of the nucellus recorded at the time of embryo-sac formation indicates an increase by eight times (Figs. 4, 5).

The activity of the basal meristem not only increases the height of the nucellus but also adds to its width. Thus, the number of cell layers in the transverse plane increases from about six (megaspore mother cell stage, Fig. 1) to about eighteen (mature embryo-sac stage, Fig. 5). This is due to vertical divisions in the basal meristem.

The activity of the nucellar tissue surrounding the megaspore mother cell is negligible in comparison to the basal region. Frequent periclinal divisions occur on the flanks of the nucellar apex. The parietal cells divide three or four times. Hence the embryo-sac is seated a few layers deeper from the nucellar apex (Figs. 3, 4).

The nucellus appears as cylindrical structure with a dome-shaped apex at the time of fertilization. The size of the mature embryo-sac is small compared to that of the nucellus. The basal meristem resembles the rib meristem of stem apices in the pattern of cell division and cell alignment in regular rows or ribs.

An examination of the ovules of other members of Nymphæaceæ may reveal the presence of characteristic meristematic zones.
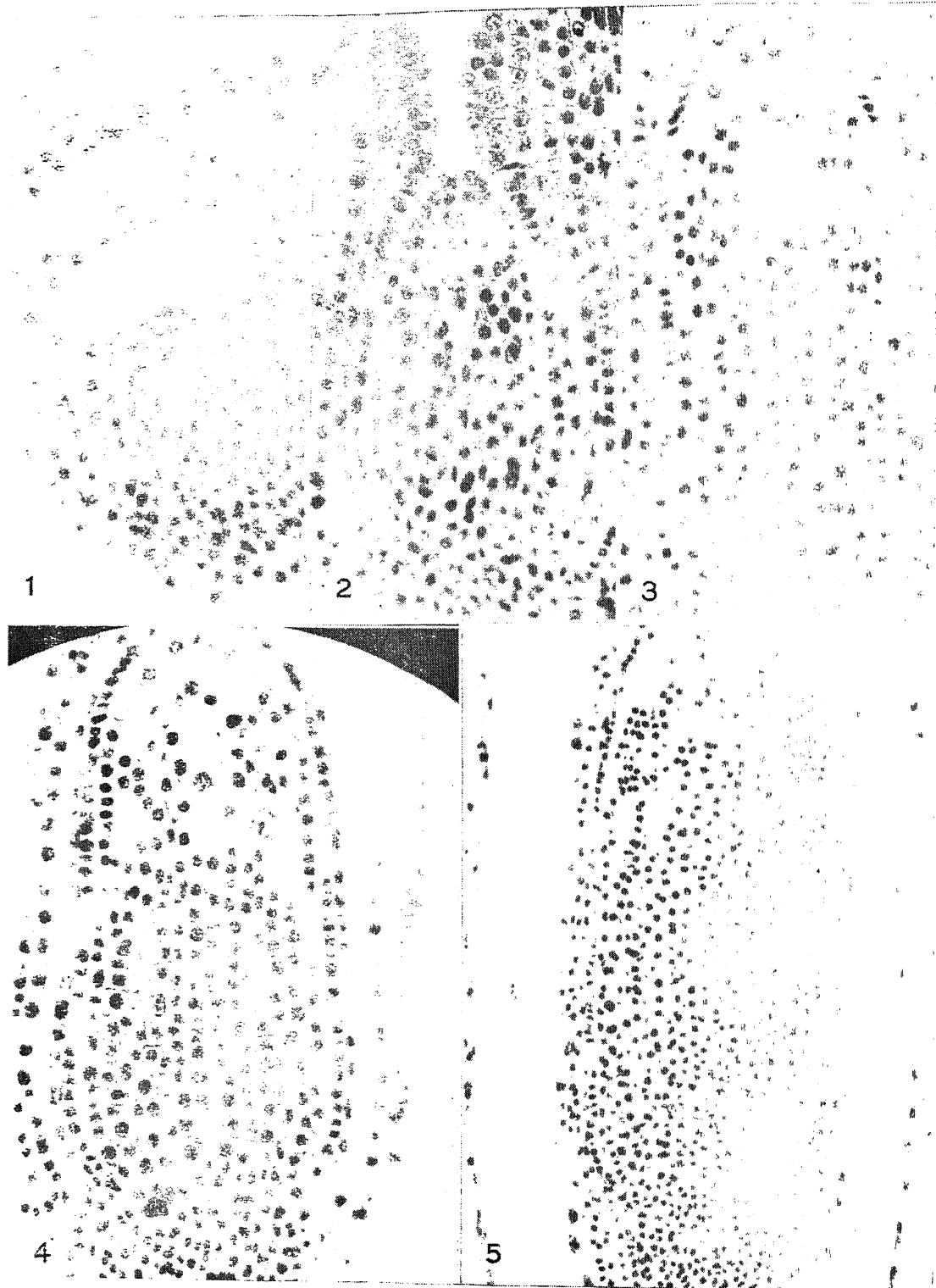
FIGS. 1-5. Fig. 1. Ovule at megaspore mother cell stage showing two integuments. The basal meristem is not yet initiated. Fig. 2. Dyad formation. Indications of a basal meristem are evident below the dividing megaspore mother cell. Fig. 3. A later stage showing the organised basal meristem. Fig. 4. Functioning vertical megaspore stage. The nucellus is considerably increased in height and width. Note the files of cells below the megaspore which is characteristic of the basal meristem. Figs. 1-4. presented at same magnification to show the activity of basal meristem, × 340. Fig. 5. Embryo-sac stage showing the increase in height and width of nucellus, × 175.

of Sciences of India for the award of a fellowship.

University Botany   M. V. RAMJI.
   Laboratory,   D. PADMANABHAN.
Madras-5 (India),
March 19, 1965.

1. Ramji, M. V. and Padmanabhan, D., *Proc. Ind. Acad. Sci.*, 1965 **B** (in press).

FORMATION OF A NEW OLIGOSACCHARIDE IN MANGO FRUITS UNDER PATHOGENESIS

RIPE fruits of 'Dashehari' variety of mango (*Mangifera indica* L.) were inoculated with *Colletotrichum glœosporioides* Penz. and were incubated at 30° C. Tissue adjacent to the inoculated region was analysed on every alternate day up to 12 days. For the detection of soluble sugars the circular paper chromatographic technique adopted by Ghosh *et al.*[1] was employed. The solvent used was *n*-butanol-acetic acid-water (4 : 1 : 5). The intensities of the bands were compared visually and graded as 10^+, 9^+, 8^+....$+$. The sign '—' has been used to denote absence of a sugar. The results are shown in Table I.

TABLE I

Presence of various sugars in mango fruits during the advancement of rot caused by Colletotrichum glœosporioides

Days of incubation	Glucose	Fructose	Monosaccharide Rf 0·75	Sucrose	Oligosaccharide Rf 0·27
Uninoculated (Control) :					
0, 2, 4	5^+	5^+	$+$	8^+	—
6, 8	5^+	5^+	$+$	9^+	—
10, 12	5^+	5^+	$+$	10^+	—
Inoculated :					
0	5^+	5^+	$+$	8^+	—
2	6^+	5^+	$+$	6^+	$+$
4, 6	5^+	5^+	$+$	4^+	3^+
8	4^+	4^+	—	2^+	$+$
10	3^+	3^+	—	$+$	Trace
12	2^+	2^+	—	—	—

It will be seen that the soluble sugars detected in mango fruits were sucrose, glucose, fructose and a monosaccharide. The Rf value of this unidentified sugar (0·75) was higher than that of arabinose (0·53), xylose (0·56) or rhamnose (0·67). Sarkar[2] has reported the presence of free xylose in mango fruits, but in the present case no xylose could be detected.

The appearance of an oligosaccharide (Rf 0·27) in the infected fruit tissue is a feature of special interest. This sugar accumulated in maximum concentration on 4–6 days of incubation. At this stage a rapid decrease in the sucrose content indicated that sucrose contributed to the formation of this oligosaccharide. This point was confirmed by growing the pathogen in an artificial liquid medium containing sucrose, whereupon a synthetic oligosaccharide (Rf 0·27) was formed. Synthesis of transient oligosaccharides in a sucrose medium has been reported by many workers, but a demonstration of similar process in infected host tissue is rare. The formation of an oligosaccharide in the tissue of papaya fruits infected with *Fusarium* sp. was the solitary instance of such phenomenon recorded by Ghosh *et al.*[1]

The fruits of guava, banana and papaya infected with different anthracnose fungi were also subjected to similar analysis, but in none of these cases any synthetic oligosaccharide could be detected—in spite of the fact that the sucrose content of these fruits was considerably high.

Department of Botany,   A. K. GHOSH.
Allahabad University,   R. N. TANDON.
Allahabad,   S. N. BHARGAVA.
January 18, 1965.   M. P. SRIVASTAVA.

1. Ghosh, A. K., Tandon, R. N., Bilgrami, K. S. and Srivastava, M. P., *Phytopath. Z.*, 1964, **50**, 283.
2. Sarkar, K. P., *Sci. and Cult.*, 1963, **29**, 51.

REVIEWS AND NOTICES OF BOOKS

Michael Faraday—A Biography. By L. Pearce Williams. (Chapman and Hall Limited, 11 New Fetter Lane, London E.C. 4), 1965. Pp. xvi + 531. Price 70 *sh.*

This book is a product of years of research and preparation and is intended to be a biography of Faraday which will supersede all that has gone before it and to remain the standard work on the subject for many years to come. The author has drawn on all available sources of information, including many that have never before been published. The author describes the development of Faraday's ideas when confronted with empirical evidence and the ways in which they led to his discoveries beyond the conception of his more orthodox contemporaries. The tenacity and courage he showed in the face of increasing official opposition to his work form a story which will appeal to the general reader and to those with a more specialised interest in the subject.

The book is illustrated with numerous pictures of both Faraday and his contemporaries which add to the attractiveness of the work.

C. V. R.

Silicate Science (Vol. II)—*Glasses, Enamels, Slags.* By Wilhelm Eitel. (Academic Press, New York and London), 1964. Pp. xii + 707. Price : List Price $ 26.00 ; Subs. Price $ 23.00.

Silicate Science is a treatise in five volumes which will provide investigators with information on the basic chemistry of silicates and their natural and industrial significance in glass, ceramic, and construction material practice.

Volume I of this series which dealt with Silicate Crystal Structures, Clay Mineral Structures and Silicate Dispersoids has already been reviewed in *Current Science*, June 5, 1965, page 357.

The present volume of the treatise combines the principles of physics and chemistry of glass and its constitution with the basic facts of glass technology. It presents all necessary information on glass formation, properties and theory.

The book is divided into three sections. Section A delineates the progress that has been made in the theory of glass constitution and the reconciliation between previously contrasting hypotheses of structural characteristics. The

infra-red absorption and radioactive tracer methods, which have become increasingly important to glass investigation, are treated in this section. Section B covers the advances in industrial glass and enamels. Section C deals with metallurgical slags. Two important new developments which are discussed are the application of silicate melt equilibria of systems containing iron oxides and the role of phosphoric acid in the melts of pig-iron slags.

C. V. R.

Lectures on the Many-Body Problem (Vol. 2). Edited by E. R. Caianiello. (Academic Press, New York and London), 1964. Pp. xi + 294. Price $ 10.50.

This volume contains a series of lectures by various authors in the field. The following is a list of the lectures and of the lecturers : Introductory Remarks on Solid-State Physics, by R. E. Peierls ; Discontinuities in the Drift Velocity of Ions in Liquid Helium, by G. Careri, S. Cunsolo, P. Mazzoldi and M. Vicentini-Missoni ; Density Fluctuation Excitations in Many-Particle Systems, by D. Pines ; The Electron-Phonon Interaction in Normal and Superconducting Metals, by Leo P. Kadanoff ; Special Effects in Superconductivity, by P. W. Anderson ; Tunnelling from a Many-Particle Point of View, by R. E. Prange ; Superconductivity with p- and d-Wave Pairing, by R. Balian ; Electrons in Disordered Systems, by J. L. Beeby ; Oscillations of a Quantum Electron Gas in a Uniform Magnetic Field, by Eric Canel and N. David Mermin ; Temperature-Dependent Random Phase Approximations for the Heisenberg Ferromagnet, by G. Horwitz ; Renormalization in Equilibrium Statistical Mechanics, by Cyrano De Dominicis ; Liouville Representation of Quantum Mechanics with Application to Relaxation Processes, by U. Fano ; The Mathematics of Second Quantization for Systems of Fermions, by E. R. Pike ; Correlation Functions and Macroscopic Equations, by Paul C. Martin. C. V. R.

Advances in Quantum Chemistry (Vol. 1). By Per-Olov Lowdin. (Academic Press, New York and London), 1964. Pp. xi + 385. Price 100 *sh.*

The purpose of this series is to present a survey of the current development of quantum

chemistry by authors who have been invited to give their personal points of view of the subject. The articles contained in the present volume and their respective authors are listed bleow: (1) The Schrödinger Two-Electron Atomic Problem, by Egil A. Hylleraas; (2) Energy Band Calculations by the Augmented Plane wave Method, by J. C. Slater; (3) Spin-Free Quantum Chemistry, by F. A. Matsen; (4) On the Basis of the Main Methods of Calculating Molecular Electronic Wave Function, by R. Daudtl; (5) Theory of Solvent Effects on Molecular Electronic Spectra, by Sadhan Basu; (6) The Pi-Electron Approximation, by Peter G. Lykos; (7) Recent Developments in the Generalized Hückel Method, by Y. I'Haya; (8) Accuracy of Calculated Atomic and Molecular Properties, by G. G. Hall; and (9) Recent Developments in Perturbation Theory, by Joseph O. Hirschfelder, W. Byers Brown and Saul T. Epstein.　　　　C. V. R.

Concepts in Quantum Mechanics (Vol. 18) of Pure and Applied Physics. By F. A. Kæmpffer. (Academic Press, New York and London), 1964. Pp. xiii + 358. Price $ 9.75.

The present work is an attempt to present advanced quantum mechanics from an elementary point of view. The book emphasizes the description of symmetry properties without the use of group theory and the elementary treatment of such topics as time-reversal invariance, super-selection rules, and the interaction picture.

The whole subject is dealt with systematically in thirty sections with seven appendices. This volume may be used successfully as the text for an introductory course for graduate students or as a supplementary reference for more standard treatments.　　　　C. V. R.

Advances in Protein Chemistry (Vol. 20). Edited by C. B. Anfinsen, M. L. Anson, J. T. Edsall and F. M. Richards. (Academic Press, New York and London), 1965. Pp. xx + 369. Price $ 14.50.

Volume 18 of this well-known series was reviewed in *Current Science*, May 5, 1965 and volume 19 in June 20 issue.

The present volume contains the undermentioned articles: (*i*) Thrombosthenin, the Contractile Protein from Blood Platelets and Its Relation to Other Contractile Proteins, by M. Bettex-Galland and E. F. Luscher; (*ii*) Hydro-

lysis of Proteins, by Robert L. Hill; (*iii*) The Unusual Links and Cross-Links of Collagen, by John J. Harding; (*iv*) The Chemistry of Keratins, by W. G. Crewther, R. D. B. Fraser, F. G. Lennox and H. Lindley. All the articles are followed by an extensive bibliography.

　　　　C. V. R.

Structure and Activity of Enzymes. Edited by T. W. Goodwin, I. S. Harris and B. S. Hartley. (Academic Press, New York and London), 1964. Pp. viii + 190. Price 37 sh. 6 d.

This book reports the symposium organised by the Federation of European Biochemical Societies and held at London in the year 1964. Some twenty-five contributions appear in the volume and they are grouped under the four following headings: (1) Ribonuclease; (2) Chymotrypsin; (3) Active Sites and (4) Hæmoglobin.

The entire symposium emphasizes the new light which has been thrown on the mechanism of enzymic catalysis by studies of the structure of enzyme proteins. Four special topics selected for special consideration: *Chemical modification* of the protein can identify groups which react with the substrate; *The amino-acid sequence* defines the framework in which active groups of the enzyme are placed; *X-Ray crystallography* provides new hope of determining the complete structure of enzymes; and *Enzyme kinetic investigations* take on a new meaning against this background.　　　　C. V. R.

Introduction to Modern Biochemistry, Second Edition. By P. Karlson. (Translated by Charles H. Doering.) (Academic Press, New York and London), 1965. Pp. xviii + 436. Price $ 11.00.

The first edition of this book published less than two years ago was reviewed in *Current Science*, September 20, 1964, pp. 566-567, and that the new edition has been called for so quickly is an indication of the warmth of its reception.

The book is written primarily for the introductory undergraduate course in biochemistry. Concise and well-illustrated, the text presents introductory theories and procedures of biochemistry, and demonstrates modern research applications. Utilizing the most up-to-date concepts, Dr. Karlson provides a dynamic approach to biochemistry that emphasizes biological significance.

The recent findings of major research activity and advances in biochemistry have been

incorporated into this Second Edition. Improvements have been made throughout the book, entirely updating and expanding the material.

<div align="right">C. V. R.</div>

Contributions to Sensory Physiology (Vol. 1). Edited by William D. Neff. (Academic Press, New York and London), 1965. Pp. x + 274. Price $ 7.50.

This new continuing series is based upon a broad definition of sensory physiology ranging from microscopic anatomy to psychophysics. The articles included in each volume are expository rather than summary. In addition to providing a valuable reference for current sensory system research, it is the purpose of this series to present detailed accounts of series of experiments and original theories concerning the physiological basis of sensation. Contents of this volume include : Cellular Pattern, Nerve Structures, and Fluid Spaces of the Organ of Corti ; Functional Anatomy of the Vestibular and Lateral Line Organs ; Psychophysiological Studies of Vestibular Function ; Behavioral and Electrophysiological Studies of Primate Vision and Vision in Intermittent Light.

<div align="right">C. V. R.</div>

The Physiology of Insecta (Vol. 2). Edited by Morris Rockstein. (Academic Press, New York and London), 1965. Pp. xvi + 905. Price : List Price $ 33.00 ; Subs. Price $ 29.50.

The first volume of this treatise was reviewed in *Current Science*, May 5, 1965, page 296. In this volume, the interaction of the insect with and its reaction to both its physical and biotic environments are considered further. The work is dealt with in fourteen chapters and the titles with their respective authors are as follows : (1) Physiology of Insect Behaviour, by H. Markl and Martin Lindauer ; (2) Social Behavior and Mutual Communication, by Martin Lindauer ; (3) Migration, by C. G. Johnson ; (4) Locomotion : Terrestrial, by George M. Hughes ; (5) Locomotion : Swimming (Hydrodynamics) of Aquatic Insects, by Werner Nachtigall ; (6) Locomotion : Flight, by J. W. S. Pringle ; (7) Neural Integration (Central Nervous System), by F. Huber ; (8) Neural Control of Skeletal Muscle, by Graham Hoyle ; (9) The Biochemistry of the Contractile Elements of Insect Muscle, by Koscak Maruyama ; (10) Energetics and Respiratory Metabolism of Muscular Contraction, by Bertram Sacktor ; (11) Intermediary Metabolism of Carbohydrates in

Insects, by W. Chefurka ; (12) Intermediary Metabolism of Nitrogenous and Lipid Compounds in Insects, by W. Chefurka ; (13) Insect Nutrition, by H. L. House ; and (14) Digestion, by H. L. House.

<div align="right">C. V. R.</div>

Modern Genetics (Vol. 1). By J. A. Serra. (Academic Press, New York and London), 1965. Pp. xii + 540. Price 105 *sh.*

In this greatly expanded English edition of a book originally published in Portuguese, Professor Serra presents a well-balanced work on general genetics that is both authoritative and stimulating. Recent data and advances in microbial and molecular genetics have been fully integrated into the basic frame of classical genetics to provide a comprehensive basic book for the advanced student and an excellent source of reference for the post-graduate research worker.

On the basis of recent work, including his own and that of his collaborators, Professor Serra puts forward many original ideas and suggests new lines of investigation. This approach will make the work valuable to all research workers in this field and help post-graduate students to keep an open mind on matters that are still largely controversial. The work is complete in three volumes.

<div align="right">C. V. R.</div>

The Role of Chromosomes in Development— *23rd Symposium of the Society for Study of Development and Growth.* (Academic Press, New York and London), 1964. Pp. xii + 290. Price 88 *sh.*

This symposium presents analyses of the structure and function of chromosomes in a wide variety of organisms. The topics covered are : the role of chromosomes in development ; structural patterns and the functional organization of chromosomes ; chromosomal proteins ; binding of actinomycin as a model for the complex-forming capacity of DNA ; DNA replication sequences in higher animals ; localised DNA synthesis in polythene chromosomes and its implications ; chromosomal RNA and other nuclear RNA fractions ; genetic and functional mosaicism in the mouse ; genetic repression of R_t action in maize ; genetic control and regulation of developmental pathways and macronuclear differentiation and subnuclear assortment in ciliates.

<div align="right">C. V. R.</div>

Physics of Thin Films (Vols. I and II). Edited by Georg Hass and Rudolf E. Thun. (Academic Press, New York): Vol. I: (1963), Pp. xi + 350. Price $ 13.00 ; Vol. II: (1964), Pp. xii + 441. Price $ 15.00.

This series is intended to present comprehensive survey articles on this growing subject of thin films in which published papers are widely dispersed. The articles will deal not only with the fundamental researches on preparation and properties but also with the applications of thin films in diverse fields as the contents enumerated below will show. These survey articles will no doubt serve on orienting and stimulating research on thin films and the series should find a 'warm welcome by the workers concerned.

The contents of the two volumes are as follows :

Vol. I : Ultra-high Vacuum Evaporators and Residual Gas Analysis, by H. L. Caswell ; Theory and Calculations of Optical Thim Films, by P. H. Berming ; Preparation and Measurements of Reflecting Coatings for the Vacuum Ultra-violet, by R. P. Madden ; Structure of Thin Films, by R. E. Thum ; Low Temperature Films, by W. B. Ittner ; and Magnetic Films of Nickel-Iron, by E. W. Pugh.

Vol. II : Structural Disorder Phenomena in Thin Metal Films, by C. A. Neugebauer ; Interaction of Electron Beams with Thin Films, by C. J. Calbick ; The Insulated Gate Thin Film Transistor, by P. K. Weimer ; Measurement of Optical Constants of Thin Films, by O. S. Heavens ; Antireflection Coatings for Optical and Infra-red Optical Materials, by J. T. Cog and G. Hass ; Solar Absorptance and Thermal Emittance of Evaporated Coatings, by L. F. Drummeter and G. Hass ; and Thin Film Components and Circuits, by N. Schwartz and R. W. Berry.

A. S. G.

Catalysis and Chemical Kinetics. By A. A. Balandin *et al.* (Academic Press, New York ; Wydawnictwa Naukowo-Techniczne, Warszawa), 1964. Pp. xii + 255. Price $ 10.00.

The contributions of Polish scientists working in the various centres of research in Poland, in the fields of catalysis and kinetics during the post-war period are reviewed in thirteen chapters by an equal number of authors. Among the review articles are "New Data on the Multiplet Theory of Catalysis, by A. A. Balandin ; The Theory of Enzymatic and Asym-

metric Catalysis, by E. I. Klabunovskii ; Some Applications of Electrical Conductivity Measurements to the Investigation of Catalytic Processes on Semiconducting Oxide Catalysts, by A. Bielanski ; Problems of Chemical Catalysis in Connection with the Fischer-Tropsch Synthesis of Hydrocarbons, by Z. Sokalski ; Mechanism and Kinetics of Certain Redox Systems in Solutions, by B. Jezowska-Træbiatowska ; and Kinetics of Reaction at the Interface of a Liquid-Liquid or Liquid-Gas, by E. Jozefowicz.

This compact volume presenting published results of Polish work, otherwise widely distributed in journals, will arouse wider interest in researches in the field of catalysis and chemical kinetics.

A. S. G.

Books Received

Fundamentals of Botany Series—Plants and the Ecosystem. By W. D. Billings. (Macmillan and Co., London W.C. 2), 1965. Pp. iv + 154. Price 12 sh. 6 d.

Non-Vascular Plants Form and Function. By W. T. Doyle. (Macmillan and Co., London W.C. 2), 1965. Pp. vi + 174. Price 12 sh. 6 d.

Vascular Plants Form and Function. By F. B. Salisbury and R. V. Parke. (Macmillan and Co., London W.C. 2), 1965. Pp. vi + 184. Price 12 sh. 6 d.

Reproduction Heredity and Sexuality. By S. A. Cook. (Macmillan and Co., London W.C. 2), 1965. Pp. vi + 117. Price 12 sh. 6 d.

The Plant Cell. By W. A. Jenseen. (Macmillan and Co., London W.C. 2), 1965. Pp. vi + 136. Price 12 sh. 6 d.

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SCIENCE NOTES AND NEWS

Award of Research Degree

Utkal University has awarded the Ph.D. Degree in Botany to Shri Banchhanidhi Misra for his thesis entitled "Autecological Studies on *Ipomoea crassicaulis* (Benth.) Robinson".

Indian Association of Biological Sciences

At a meeting of biologists held in Calcutta in January 1965, an Association called "The Indian Association of Biological Sciences" was formed. The main aim of the new Association will be to create a common forum of Indian Biologists and try to integrate the research acivities of biologists working in different fields. A Steering Committee to formulate the detailed scheme of the Association was elected at the meeting.

Any suggestions may please be communicated to Prof. T. S. Sadasivan (Secretary, IABS), University Botany Laboratory, Madras-5, or Prof. P. Maheshwari (Chairman), Department of Botany, Delhi University, Delhi.

Further information can be had from the Treasurer Dr. B. S. Chauhan, Zoological Survey of India, 34, Chittaranjan Avenue, Calcutta-12.

Symposium on Indian Medicinal Plants

A symposium on 'Recent advances in the development, production and utilisation of medicinal and aromatic plants in India' under the auspices of Central Indian Medicinal Plants Organisation (CIMPO) will be held at Lucknow on 12th, 13th and 14th January, 1966.

The symposium will confine itself to the recent developments in the production and utilisation of medicinal and aromatic plants in India since 1955.

For contribution of papers and other information, please write to Dr. S. C. Datta, Central Indian Medicinal Plants Organisation, 4, Sapru Marg, Lucknow.

Symposium on Radioactivity and Metrology of Radionuclides

An All-India Symposium on Radioactivity and Metrology of Radionuclides will be held at Trombay from December 13-17, 1965 under the auspices of the Atomic Energy Establishment, Trombay. The Symposium will cover various aspects pertinent to the problems of radioactivity measurements in fields such as radiological protection, studies of natural radioactivity, applications of radioisotopes in physical and life sciences and industry and radioisotope standardization.

Scientists wishing to participate in the Symposium are requested to write to Dr. U. C. Gupta, Secretary, All-India Symposium on Radioactivity, etc., N.I.S. Section, Electronics Division, Atomic Energy Establishment, Tromaby, Bombay-74 AS.

Symposium on "CNS-DRUGS"

A symposium on "CNS-DRUGS" will be held from 24-30 January 1966 at Regional Research Laboratory, Hyderabad (India), one of the constituent laboratories of Council of Scientific and Industrial Research, Government of India. The Symposium is expected to be attended by about 45 invited participants from India and abroad. The proceedings of the Symposium will be published by the middle of 1966 by the Council of Scientific and Industrial Research, New Delhi. Further details about the Symposium may be obtained from Dr. P. B. Sattur, Regional Research Laboratory, Hyderabad-9.

Molecular Crystals, an International Journal

Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York City 10011, announce plans to publish a new quarterly journal entitled *Molecular Crystals*, under the editorship of G. J. Dienes, Brookhaven National Laboratory and M. M. Labes, Franklin Institute Research Laboratories. This journal will publish original research papers dealing with molecular crystals and related topics such as crystallinity in polymers, liquid and plastic crystals and systems of biological interest.

As a quarterly publication with the first issue commencing January 1966, the subscription rate will be $ 20.00 per year, with a special rate to individuals of $ 9.50.

THE NEW PHYSIOLOGY OF VISION

Chapter XXIII. The Colours of the Roses

SIR C. V. RAMAN

ROSES have been known in India for ages past and have been highly esteemed for their beauty and fragrance. It is scarcely possible, therefore, to commence a paper on the colours of roses without some reference to the Indian rose known botanically as *Rosa Indica semperflorence*. It is a shrub which is exceedingly vigorous in growth and flowers both freely and perpetually. The blooms are shapely, each having some forty petals. They appear as clusters at the end of tall canes growing up from the base of the shrub and are characterised by their soft pink colour and a sweet scent which perfumes the air around. These roses have been in extensive cultivation for various purposes, in particular for the production of the essential-oil perfume known as Attar. If groups of these shrubs are planted out in a garden, they make a very satisfying show of colour.

The reason why it appeared desirable to devote a whole chapter to the colours of roses is that the rose has long been a highly popular flower and enthusiastic rose-lovers are to be found all the world over. Interest in the rose continues unabated and thousands of varieties of it have been created by crossing and inter-crossing the different species with each other. The colour of a rose forms a major part of its æsthetic appeal. Quite naturally, therefore, colour has been a decisive factor in the development, selection and propagation of new varieties. How far this activity has proceeded will be evident from *The Pocket Encyclopædia of Roses* (1963), published by the Blandford Press in London. No fewer than 421 named varieties have been reproduced in full colour in that publication. It is stated that great care was taken to achieve a high degree of accuracy in the representation of the colours and to secure such accuracy, the illustrations were printed in six colours. Seeing these pictures, one may well ask, why do roses exhibit such colours and why do the different roses differ so markedly from each other ? It is the purpose of this chapter to present answers to these questions.

The Colour Categories.—The colour of a flower has its origin in the presence in its petals of a material which we may refer to as the floral pigment. This exercises an absorption on light which is of a selective nature, greater in some parts of the visible spectrum and much less or even absent in other parts of it. As a consequence, diffuse daylight which is incident on the petals before it can emerge again from them after internal scattering has its spectral constitution much altered, some parts of the spectrum being weakened relatively to the others. When the light having this altered spectral character reaches the eyes of an observer, the characteristics of the visual mechanism determine the results of the visual synthesis and hence also the perceived colour. Thus, the colour exhibited by a rose is determined by our faculties of perception and by the spectral characters of daylight as it emerges after diffusion within the petals, these characters being themselves dependent on the quantity of floral pigment contained in the petals and its absorptive properties.

In the preceding chapter, a scheme for the classification of floral colours was suggested. This was based on the subdivision of the visible spectrum into four parts, consisting respectively of the blue sector, the green sector, the yellow sector and the red sector. Of these four, the yellow sector covers the narrowest range of wavelengths but nevertheless transcends all the others in respect of its influence on the perceived colour. Placing the four sectors in the order stated and indicating by the symbol 1 the absence of absorption and by the symbol 0, a complete absorption of the sector concerned, we obtain sixteen categories of colour which are indicated by the appropriate symbols. The eight categories which here concern us are (1111), (0111), (0011), (0001), (0000), (1001), (1011) and (1101). These represent colours which may be termed respectively as white, yellow, orange, red, black, pink, rose and purple. These assignments are based on spectroscopic observations of a great many flowers exhibiting various colours. If the absorption

of light is not actually complete for any particular sector, the colour sensation which results is weaker, but is not altogether different. Thus the categorisation of colour may be regarded as having an extensive range of validity. Its usefulness depends on the fact that it enables us from the perceived colour to infer the part or parts of the spectrum where the absorption by the floral pigment is effective, and then proceed to verify this by direct observation.

Spectroscopic Behaviour of Roses.—To ascertain the region or regions of the spectrum on which the floral pigments exercise their specific absorption, all that is necessary is to hold the flower in sunlight, or alternatively in diffuse daylight of sufficient intensity and view it through a direct-vision spectroscope. Comparison with the spectrum of a white diffusing screen observed under similar conditions immediately reveals the nature and extent of the alterations in the spectrum of the flower resulting from the presence in its petals of the floral pigment or pigments. This simple technique reveals that the absorption in roses which exhibit the various shades of cream or yellow appears in the blue sector of the spectrum, in other words in the wavelength range between 400 mμ and 500 mμ, while other parts of the spectrum are entirely unaffected. The absorption is partial when the colour is a cream or a pale yellow. But it is more strongly manifested by the more vividly coloured roses and is complete in the cases of roses which exhibit a deep yellow colour.

The spectroscope reveals that the soft pink colour of the Indian rose referred to at the commencement of this chapter has an entirely different origin. On a comparison of the light diffused by it and by a white screen, it is seen that the red sector of the spectrum appears with undiminished intensity and that the blue sector also appears with practically undiminished brightness. On the other hand, the green sector ranging from 500 mμ to 560 mμ is much weakened, and the yellow sector between 560 mμ and 600 mμ is just perceptibly dimmed. A fuller idea of the spectroscopic behaviour of the floral pigment contained in the petals of this rose may be obtained by examining the light which penetrates through its individual petals when they are held up against the bright sky and the slit of the instrument is held immediately behind the petal. Making this observation first with a single petal held by itself and then with two petals, then with three petals and finally with four petals held together, we find that while the red sector comes through freely in all cases, the green sector is progressively weakened and is almost completely extinguished when three petals are held together. The blue sector which is conspicuously visible with one petal is weakened in its passage through two petals, and is only seen with difficulty through three petals. A progressive weakening of the yellow sector is also evident as the number of petals is increased. With four petals, we have a complete extinction of all the sectors except the red which remains conspicuously visible.

It may be inferred from what has been stated above that the pink colour exhibited by many roses has its origin primarily in the absorption of light appearing in the green sector of the spectrum ; the more complete this absorption is, the deeper would be the pink. Observations with roses exhibiting different shades of pink indeed show a progressive change in the spectral characters of the light diffused by the petals analogous to those described above resulting from the passage of light through a number of petals held together.

Red and Crimson Roses.—Examination of the light diffused by the petals of roses which exhibit a red colour, as also of those which appear of a crimson hue, reveals some remarkable features. The green sector of the spectrum is much weakened. But, in addition, we observe a dark band covering the wavelength range from 560 mμ to 600 mμ, in other words a complete extinction of the yellow sector of the spectrum. The blue sector of the spectrum is much weakened but is not totally extinguished. The wavelength region between 480 mμ and 500 mμ also appears distinctly darker than the parts of the spectrum on either side of it. In the spectrum of the light transmitted through a petal of a red or a crimson rose, the extinction of the green sector between 500 mμ and 560 mμ is complete, while the red sector is seen in full strength. The blue and yellow sectors are much weakened but not totally extinguished.

Scarlet Roses.—The roses exhibiting a scarlet hue form a distinct class by themselves. The difference in colour between a scarlet rose and a red rose is sufficiently striking to be unmistakable. It also reveals itself in the character of the spectrum diffused by the petals. The scarlet colour arises from a strong absorption in the wavelength range between 480 mμ and

560 mμ. Light of greater wavelengths however comes through freely. The blue sector is weakened but can nevertheless be observed. As seen by transmission through the petals, the same features are noticed but are then more accentuated. The difference between scarlet and red roses thus lies in the greater transparency of the former to the yellow sector of the spectrum.

Orange Roses.—The transparency to the yellow of the spectrum exhibited by the scarlet roses is shown even more conspicuously by the roses of an orange hue. Here again, the perceived colour is a consequence of the absorption in the green sector between 500 mμ and 550 mμ which is complete, while all greater wavelengths appear with undiminished strength. The blue sector is weakened but can nevertheless be observed in the wavelength range between 420 mμ and 470 mμ. The blue sector is still weaker in the transmitted light, while the rest of the spectrum shows features similar to those observed by reflected light. The orange roses can thus be placed in the category (0011), but this description ignores the presence of the blue sector though much weakened in the spectrum. We have here a clear case of the masking of a weaker by a stronger sensation, the effect of the yellow and red sector acting in concert overpowering that of the weakened blue sector.

Extraction of the Floral Pigment.—It is quite easy to remove the pigments from rose petals and thereby enable their absorption spectra to be independently studied. All that is necessary is to place the petals in a glass beaker and pour sufficient acetone to cover them completely. In a very few minutes, the pigments are dissolved out by the acetone, leaving the petals free from colour. The extract is quickly filtered and poured into the observation tube. It is useful to have four such tubes of different lengths, *viz.*, 3 cm., 5 cm., 8 cm., and 10 cm., each provided with flat ends. The quantity of the petals used can be varied suitably according to the depth of colour of the rose. For a deeply coloured extract, the tubes of smaller length are more useful. *Vice versa*, for weakly coloured extracts, the longer tubes are more convenient. Using this technique, a proper comparison between the pigments of roses exhibiting different depths of colour becomes possible. Two matters of detail may be men-

tioned here which are of some importance. The source of light used for the observations should be a tungsten filament lamp run at a high temperature to give white light of sufficient intensity. The observations should also be made with the acetone extract immediately after its preparation.

The Absorption Spectra of the Floral Pigments.—It will suffice here briefly to record the results of the studies of the colour of roses as observed with the acetone extracts. With yellow roses, we obtain solutions having a golden-yellow hue. Examination of the light transmitted through the observation tube containing the solution shows a complete absorption of the blue sector of the spectrum. Such absorption also extends a little beyond 500 mμ, exhibiting an ill-defined edge in the wavelength range between 490 mμ and 520 mμ. The absorption spectra of the pigments contained in yellow roses thus resemble those of the carotenoids.

The colour of the extracts made with other roses depends a good deal on the quantity of the material used for the extraction and the volume of acetone added. Speaking generally, however, it may be said that the colour of the extract resembles the colour of the roses from what it is derived. The studies establish clearly that the pigments appearing in pink roses of various shades, in the red roses and in the crimson roses are of an identical nature, the quantities of pigment present, however, being very different. In all such cases, with the appropriate concentrations, we observe a powerful absorption in the green sector, and in addition a fairly well-defined dark band in the wavelength range between 530 mμ and 555 mμ. There is also a general absorption of the yellow sector extending from 555 mμ to 600 mμ and in addition a well-defined absorption band between 580 mμ to 600 mμ. A general but rather weak absorption is also noticeable in the blue sector. It is most marked between 490 mμ and 510 mμ.

The acetone extracts from the scarlet and from the orange roses differ from those of the other roses principally in respect of the absorption of the yellow sector of the spectrum. Such absorption is present in the extracts from scarlet roses, though it is not quite as strong as in the case of the pink, red, or crimson roses. On the other hand, the acetone extracts from the orange roses do not exhibit such absorption.

MAGNETIC HYSTERESIS OF HEAT-TREATED BASALTS

C. RADHAKRISHNAMURTY AND P. W. SAHASRABUDHE

Tata Institute of Fundamental Research, Bombay

INTRODUCTION

INVESTIGATIONS on the remanent magnetism in rocks have been carried out during the last two decades the world over to provide an understanding of (a) history of the geomagnetic field in the remote past including its probable reversals, (b) polar wandering and continental drifting, etc. To exploit the true implications of the measurements to the quantities studied, it is necessary to have a complete understanding of the magnetic behaviour of rocks. Fairly simple, sensitive and fast techniques for the study of various magnetic properties of rocks have however been developed only in the last few years.

As pointed out by Nagata,[1] little information is available on the complete hysteresis curve of rocks because of the various experimental difficulties involved. We have recently developed an alternating current hysteresis loop tracer[2] for rocks, and studied the hysteresis of over a hundred basalt samples from the Rajmahal and Deccan traps as well as from a number of associated dolerite dykes. A correlation between the magnetic and mineralogical properties of these rocks will be reported soon.[3]

Very often, rocks are required to be heated to moderate temperatures (up to 600° C.) for determining the various magnetic properties such as Curie temperature (T_c), stability,[4] etc. However, since magnetic properties are very sensitive to heat treatment, knowledge of changes in the magnetic state of the rock after heat treatment assumes a great importance. We have found that the response of rocks to heat treatment is very interesting though qualitatively analogous to that of commercial magnetic substances and ferrites.

HYSTERESIS OF VIRGIN BASALTS

We have studied the hysteresis behaviour in a variety of basalts and dolerites. Such rocks in general contain grains of either magnetite or members of the titanomagnetite solid solution series, and the magnetic properties of these have been studied in great detail by several workers in the past,[5] and more recently by Uyeda.[6] It has been found that all such rocks can be saturated in fields ranging between 800 and 2400 oersteds and that they show a coercive force (H_c) from a few tens to a few hundreds of oersteds. Typical hysteresis loops for samples showing minimum H_c (45) and maximum (390) encountered in the present studies are shown in Figs. 1 a and 1 b respectively.

HORIZONTAL SCALE IS D = 60 Osfds
VERTICAL SCALE IS.D = 1 75 e m u

HORIZONTAL SCALE IS D = 120 Osfds
VERTICAL SCALE IS.D = 1 75 e m u.

(a)   (h)
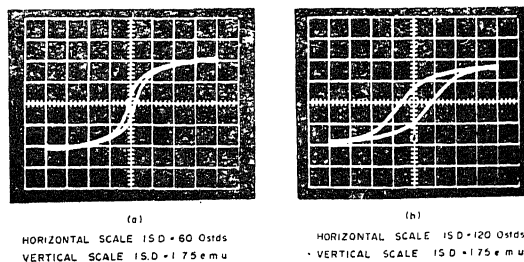
FIG. 1

HYSTERESIS OF HEAT-TREATED ROCKS

It is known from earlier studies[7,8] that the rocks considered herein contain members of titanomagnetite series and show Curie temperatures (T_c) between 180° and 580° C. We have first studied the hysteresis of rocks which were heated only up to their respective T_c. Though definite differences between the hysteresis loops of virgin and heat-treated rocks have been found they are not very striking for many of them. However, in the case of slightly weathered (or altered) rocks, a remarkable change in the value of H_c has been observed after the heat treatment of the sample up to its T_c value. Two very typical cases of this type are shown in Figs. 2 a and b, and 2 c and d. The maximum change in the value of H_c found is from 100 to 600 oersteds as shown in Fig. 2 a and b. In another fine-grained rock similar heat treatment produced a constriction in the loop which is shown in Fig. 2 c and d.

The above observations led us to do systematic and controlled heating experiments on different rock types. One typical series of hysteresis loops obtained for a specimen heated to different temperatures in air is shown in Fig. 3 a to f. It can be seen from the curves of Fig. 3 that the various magnetic parameters, H_c, saturation magnetic moment M_s and remanent magnetic moment M_r, for the same specimen are apparently interrelated and change after successive heat treatments. Most important, among the

features to be noted, is that H_c reaches a maximum value first and then the loop develops a constriction; after annealing the rock at

(a)
VERTICAL SCALE I S D. = 35 emu

(b)
VERTICAL SCALE I S D. = 35 emu

(c)
VERTICAL SCALE I S D. = 35 emu

(d)
VERTICAL SCALE I S D. = 175 emu.

HORIZONTAL SCALE I S D = 120 Osteds (COMMON)

FIG. 2

(a) VIRGIN

(b) 375° C

(c) 600° C

(d) 1000° C

(e) 1000° C (12 HOURS)

(f) 1000° C (12 HOURS)

HORIZONTAL SCALE I S D = 120
VERTICAL SCALE I S D = 175 emu.

FIG. 3

1000° C. for about 12 hours the loop looks normal but with an increase in all the above-mentioned magnetic parameters. The values of these parameters (M_r, H_c) at different stages of the experiment were also determined by ballistic method

for a cross-check and these showed very good agreement with the ones obtained from the overall hysteresis loops. The results obtained from a number of experiments of the above are summarized in the following:

(1) The general pattern of magnetic behaviour of basalts and dolerites after sucessive heat treatments is of the type shown in Fig. 3 a to f, although the sequence of changes and the temperatures at which they occur may be different for different specimens.

(2) Slightly altered rocks and also unaltered fine grained glassy samples attain a maximum H_c of the order of 400 to 600 oersteds, on heating to 400 to 600° C.

(3) After a specimen has acquired a maximum H_c, further heating generally produces a constriction in the hysteresis loop.

(4) Annealing at somewhat higher temperatures ($\sim$ 1000° C.) probably homogenises the magnetic phases in rocks so that they exhibit normal hysteresis loops with some increase in H_c and either increase or decrease in M_s and M_r.

(5) The Curie temperatures of the specimens after different heat treatments remain close to those of virgin specimens (when between 400 and 580° C.) indicating that the predominant magnetic mineral in them does not undergo any major alteration such as magnetite to hematite. This observation has also been confirmed by similar experiments on a natural crystal of magnetite which did not show any changes in the magnetic behaviour after the various heat treatments. This clearly shows, contrary to general belief, that major chemical changes in magnetic minerals in rocks are not easily produced to any appreciable extent by heating in air alone. On the other hand, it is well known that the rocks showing T_c less than 300° C. in the virgin state generally stabilize after heat treatment and show a T_c around 500° C. This phenomenon is believed to be due to submicroscopic exsolution of ilmenite from the original titanomagnetite in the rocks.

(6) It is not possible to heat all types of basalts to 1000° C. and retain the original shape and size as many of the silicates in rocks soften at this temperature. In general, specimens which withstood heating to 1000° C. without any major damage showed an increase in volume of a few per cent.; whereas those containing glassy material or volatile products expanded greatly developing bubbles and cracks,
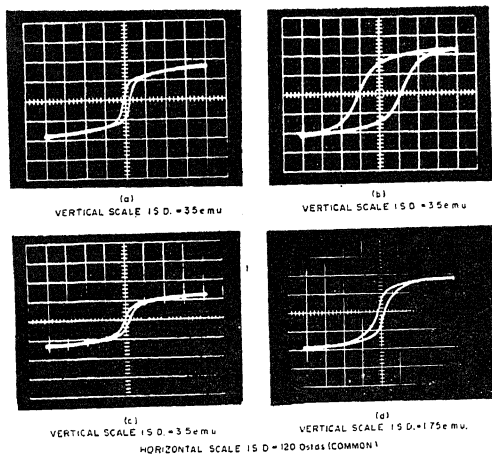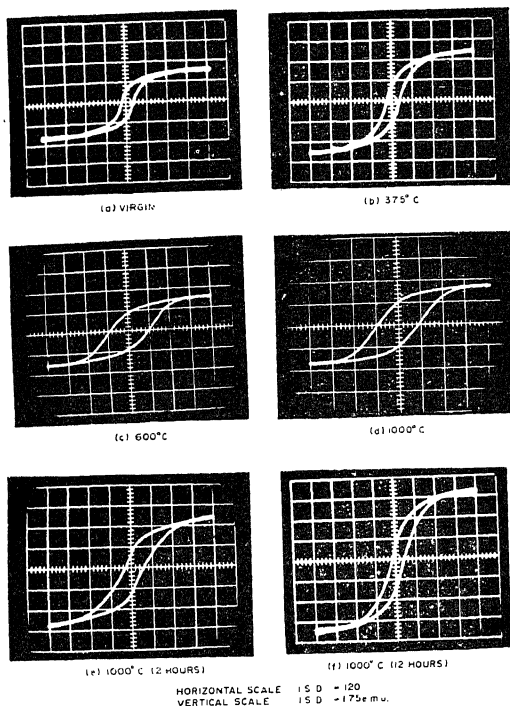
DISCUSSION OF RESULTS

Basaltic rocks contain a few per cent. of ferromagnetic grains, varying in size from a few to over a hundred microns, and disseminated more or less uniformly in non-magnetic matrix of silicates. The maximum H_c reported for virgin specimens of such rocks is around 300 oersteds. But the values of around 500 oersteds have been observed for ferromagnetic impurities (of even iron) disseminated in brass[9] or other non-magnetic metals or alloys. It is difficult to explain coercivities greater than 500 oersteds by boundary wall movements in multi-domain grains even in case of permanent magnet alloys. To account for high H_c values Stoner and Wohlfarth[10] put forth a theory in which they postulate a segregation of single domain particles (or islands) in relatively less magnetic matrix. That is, two different magnetic phases are required to account for H_c greater than 500 oersteds. In general, segregation or presence of at least two different magnetic phases resulting in a substance after suitable heat treatment are believed to be responsible for producing H_c higher than 500 oersteds and constrictions in the hysteresis loops. The case of constricted loops has been discussed by us in an earlier paper.[11]

From our studies on rocks it is clear that they also behave in a way similar to magnetic alloys and ferrites on heat treatment. In view of the extreme complexity of rocks in their mineralogical character, it is very difficult to pinpoint the various magnetic phases taking part in the over-all magnetic behaviour of rocks subjected to heat treatment. Nevertheless, it is quite gratifying to note that the magnetic behaviour of rocks is similar to that of well-known magnetic substances. One has to be very cautious in assuming that the state of a rock remains the same after a particular heat treatment. In fact our experiments clearly indicate that one is more justified in presuming that the state of a rock is different before and after heating unless shown to be otherwise.

ACKNOWLEDGEMENT

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INTERNATIONAL SYMPOSIUM ON ENDOCRINOLOGY OF INVERTEBRATES— JENA, 1965

IN connection with the centenary celebrations of the Zoologisches Institut of the Freiderich Schiller University of Jena in the German Democratic Republic, an International Symposium on Endocrinology of Invertebrates was held from 11th to 13th June 1965. Nearly a hundred biologists, drawn from 14 nations participated in the symposium, and twenty-four papers were presented at the Conference. The symposium was held in five sessions.

The opening contribution was from Hauenschild (Freiburg) on the hormonal control of regeneration and reproduction in Nereids in which he pointed out that the ablation of brain results in maturation and realization of hetero-nereid forms ; that sex development and regeneration were inversely related and that when one gets accelerated the other gets retarded. He also pointed out the influence of photoperiod and lunar influences on the phenomena. Gabriel (Rostock) then presented his paper on the neurosecretory system and pathways and their ontogeny in aphids in relation to their life-cycle and suggested that the pericardial cells and the oenocytes may aid in transport. Penzlin (Rostock) described in *Periplaneta,* that the pars intercerebralis forms a deciding centre in regeneration of legs. The hormonal control of circadian rhythms in insects was described by Rensing (Göttingen), who showed that in

Drosophila the neurosecretory cells of the pars intercerebralis show a rhythmic activity in secretory cycle dependent on photoperiod. Messner (Greifswald) presented in his paper on the isopods *Porcellio* and *Oniscus*, that the Y organ functions as the source of moulting hormone while the B cells-Sinus glands inhibit moulting. Electron microscopic structure of the androgenic glands of *Orchestia* and *Carcinus* was then given by Meusy (Paris), who also showed that removal of eyestalks results in the hypertrophy of the glands. Schaffel (Jena) in his account of the structure of the cerebral glands of *Lithobius* under the electron microscope described the similarities between these glands and the corpora cardiaca of insects. Ozeki (Tokyo) showed in the earwig *Anisolabis*, that juvenile hormone secretion was not under the influence of the cells of the pars intercerebralis and that the corpora allata become progressively inactivated in successive stadia of life-history. Novak (Prague) discussed his gradient factor theory on the presence of an intracellular growth factor localised in regions where growths occur, in relation to nucleic acids and protein synthesis. Karlson (Marburg) spoke in brief about the chemical structure of ecdysone as he has now analysed this hormone fully. Bretschneiderova (Prague) gave her findings that in the blood of *Pyrrhocoris* during metamorphosis, implantation of corpus allatum produced changes in the average amount of hæmolymph proteins. Nayar and Adiyodi (Trivandrum) presented their findings on the disturbance of the functions of the corpus allatum in *Periplaneta* by the administration of clomiphene which interfered with the gonadotropin production, egg production, yolk deposition, colleterial secretion, and the neurosecretory release of presumably allatotropin and myotropin. Loher (Tübingen) in his paper on endocrine control of reproduction in female *Gomphocerus* explained how the pars intercerebralis activates the development of oocytes, and detailed the relationship between corpora allata, proteinase activity, yolk deposition, and changes in protein concentration in blood. Rohdendorf (Prague) showed in females of *Thermobia* that the corpora allata are needed throughout the reproductive period and that their absence will induce resorption of eggs and failure of growth of ovipositor. Nayar and Gomez (Trivandrum) described the gonadotropic effects of extracts of insectan corpora allata, on the crab *Paratelphusa*, the gonad-stimulating functions of implanted brains of crabs themselves irrespective of age, sex or season, and the relationship between a set of secretory cells in the eyestalk, other than the already known centers, and reproduction in the female. Unger (Magdeburg) in *Carausius*, showed that the isolated neurohormone C delays dye absorption in the malpighian tubule, while neurohormone D accelerates it. Gilbert and Goodfellow (Evanston) presented their paper dealing with the biochemical findings about JH in the silkmoth *Hyalophora*, pointing out that the JH is different from farnesol and suggested that evidences are accumulating to show that all insect growth hormones may be steroids or isoprenoid derivatives. In the concluding lecture given by Gersch (Jena) he traced the evolution of hormonal system in animals, and stressed the similarity in the neurosecretory system in the various groups of arthropods and vertebrates ; he also pointed out that special neurosecretory centres have also been developed in course of evolution like the urophysis of fishes. It was a fitting commemoration lecture and tribute to Ernst Haeckel, who established the Zoologisches Institut at Jena, one hundred years ago. A farewell dinner in the Jenaer Klub on the night of 13th June terminated the deliberations of the symposium.

The participants owe a debt of gratitude to Prof. Gersch, the Convener of the symposium and to Dr. Ude and the Tagungsbüro for all arrangements and help. The symposium would have been more enjoyable to the participants from abroad, if individual translation-dial facilities were afforded.

The detailed papers will be published as a special volume of *Zoologisches Jahrbucher* Abt. *Physiologie.*

K. K. NAYAR,

LETTERS TO THE EDITOR

MICRO DETERMINATION OF COPPER IN BIOMATERIALS BY NEUTRON ACTIVATION ANALYSIS

THERE are a number of conventional chemical methods available for the determination of copper in microgram quantities.[1-3] The method of activation analysis not only increases the sensitivity of detection limit of copper[4] but also eliminates the necessity for running 'blank' analyses on the reagents since the impurities contained in the reagents are not measured. Of the two natural isotopes Cu^{63} and Cu^{65} having percentage abundances 69·1 and 30·9 respectively, the former has a high activation cross-section of 4·3 ± 0·2 barns and affords a suitable nuclear reaction Cu^{63} (n, γ) Cu^{64} for the estimation of copper in biomaterials. Cu^{64} decays with half-life 12·8 hr. whereas Cu^{66}, having 5·2 minutes half-life, would have completely died out during the time interval of 6 to 7 hr. required for irradiation and subsequent procedures.

For the determination, 20 to 50 mg. of ash (ashing temperature 500° C.) is taken in polythene tubes for irradiation. Standards are prepared by evaporating aliquots of standard solution varying between 1 and 5 μg. in polythene tubes. These are placed along with the samples in an aluminium can and irradiated in the "Apsara" swimming pool reactor, at a flux of 10^{11} neutrons cm.$^{-2}$ sec.$^{-1}$ for 15 to 30 minutes. The irradiated samples are dissolved in conc. HCl. 10 mg. each of nickel and copper are added as carriers, followed by 2 ml. of 60% sodium potassium tartrate for complexing iron, aluminium, etc. The solution is made ammoniacal. Nickel is precipitated by adding slowly 10 ml. of 1% W/v alcoholic solution of dimethylglyoxime. The precipitate is centrifuged out and copper is precipitated from the solution using 2% alpha-benzoinoxime in alcohol. The precipitate is separated by centrifugation. The organic matter is destroyed by nitric acid and perchloric acid. The residue is extracted with 6 M HCl (25 to 30 ml.). To the extract solution, 10 mg. of iron as ferric chloride is added and ferric hydroxide is precipitated by liberal excess of ammonia. The precipitate is removed by centrifugation. The blue colour of the supernate mixed with washings is discharged by dilute nitric acid. 10 mg. of phosphorus as diammonium hydrogen phosphate is added followed by 4 ml. of con. nitric acid and 2 ml. of 10% ammonium molybdate solution. The solution is heated to boiling and the precipitate is removed by centrifugation. Sufficient ammonia (1 : 1) is added to the supernate for the production of blue colour which is subsequently discharged by the addition of dilute hydrochloric acid. The solution is treated with 2 ml. of saturated solution of sodium sulphite solution. The solution is warmed and copper is precipitated with 2 ml. of 5% potassium thiocyanate. The precipitate is centrifuged and thoroughly washed twice with water. The precipitate is transferred on an aluminium planchet and dried. The chemical yield for the procedure is found out by weighing the precipitate. Radiochemical purity is established by the determination of half-life of $Cu.^{64}$

The standard is dissolved in conc. HCl and the separation is carried out as described for the sample.

The radioactivation method described above has been tested on the ash of marine and freshwater animals. The results are given in Table I.

TABLE I

Species	Copper content (μg./gm. of muscle)
Parapeneopsis stylifera (prawn)	3·843
Solenocera indica (prawn)	4·426
Harpodon nehereus (Bombay duck)	0·191
do.	0·112
Catla catla (Carp—freshwater)	0·693

Health Physics Division,   G. R. DOSHI.
Atomic Energy Establishment,
Trombay, Bombay-74 A.S.,
June 2, 1965.

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THE NEAR ULTRA-VIOLET ABSORPTION SPECTRA OF *ORTHO*-, *META*- AND *PARA*-FLUOROANILINES

USING path lengths ranging from 5 cm. to 100 cm. and varying the temperature of the absorption cell from −10° C. to 150° C., the near ultra-violet absorption spectra of *ortho*-, *meta*- and *para*-fluoroanilines were recorded and studied for the first time in the vapour phase.

The spectrum of *ortho*-fluoroaniline consists of about 20 red-degraded, diffuse bands in the region λ 3060–2750. Taking the intense band at ν 34584 cm.−1 as the (0, 0) band, almost all the observed bands could be interpreted in terms of eight ground-state fundamentals 261, 350, 422, 564, 803, 1178, 1251, and 1502 and nine upper-state fundamentals, 111, 294, 404, 514, 665, 795, 1134, 1245, and 1463.

In the spectrum of the meta isomer about 40 bands could be measured. These occur in the region λ 2950–2680 and are sharp and · red degraded. The band at ν 34620 cm.−1 was taken as the (0, 0) band and eight ground-state fundamentals, 116, 223, 288, 410, 452, 508, 627; and 737 and ten upper-state fundamentals, 181, 229, 289, 447, 496, 626, 698, 773, 918; and 1249 could account for the observed bands.

About 30 sharp and red-degraded bands were measured in the spectrum of the para molecule in the region λ 3100–2710 and with the band at ν 32669 cm.−1 as (0, 0), they could be interpreted on the basis of two ground-state frequencies, 153 and 457 and nine upper-state frequencies 87, 186, 311, 422, 594, 828, 1143, 1209, and 1262. The two observed ground-state frequencies correspond to the Raman[1] frequencies 164 and 454.

The detailed paper will be published shortly.

Dept. of Physics,   M. A. SHASHIDHAR.
Karnatak University,   K. SURYANARAYANA RAO.
Dharwar, *June* 10, 1965.

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SYNTHESIS OF DEHYDROELLIPTONE

ELLIPTONE, isolated from *Derris elliptica*, has the constitution (I).[1] It can be easily oxidised to dehydroelliptone (II) which on ring fission yields elliptic acid (III) having the entire carbon skeleton intact. This acid on cyclisation using acetic anhydride, sodium acetate and a little acetic acid gives dehydroelliptone.[1]

A synthesis of dehydroelliptone and elliptone has been in progress in this laboratory based on the consideration that the isoflavone part

represents the core of the rotenoids, the furan and the chroman rings being added later on. A number of tetracyclic compounds have been prepared earlier representing the intermediate stages. The synthesis of a simple pentacyclic compound, dehydrodesmethoxy elliptone (IV),
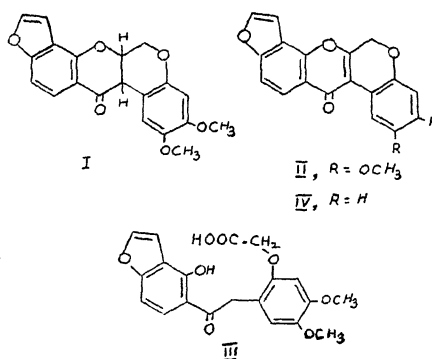
was also reported earlier.[2] That of dehydro-elliptone itself has now been accomplished as the simplest representative of the naturally occurring pentacyclic compounds. In view of the recent publication of a note by Fukami *et al.*[3] we give below the essential details of the procedure adopted by us. Starting with 7-hydroxy-2′, 3′, 4′-trimethoxy isoflavone[4] the furan ring is constructed to give elliptol iso-flavone. For building up the chromen ring partial demethylation of the 2′-position has been done followed by a number of steps.

7-Hydroxy-2′, 4′ 5′-trimethoxy isoflavone (V) was allylated and the 7-allyl ether (VI), m.p. 138–39°, when subjected to Claisen migration, gave the 8-allyl compound (VII), m.p. 228–29°. Oxidation with osmium tetroxide followed by reaction with sodium metaperiodate of (VII) afforded the 8-acetaldehyde (VIII), which on treatment with polyphosphoric acid gave elliptol isoflavone (IX), m.p. 183–84°, in good yield. This isoflavone was synthesised earlier by Fukui *et al.*[5] starting from (V) but by adopting a different route. The present procedure is far more convenient.

Elliptol isoflavine smoothly underwent partial demethylation at the 2′-position with aluminium chloride in acetonitrile to give the 2′-hydroxy compound (X), m.p. 204–05°, which on refluxing with bromoacetic ester in acetone solution in presence of anhydrous potassium carbonate gave compound (XI), m.p. 180–81°. This intermediate underwent ring opening with dilute aqueous ethanolic alkali to give elliptic acid, m.p. 190°,

in fairly good yield. Subsequent cyclisation as indicated above yielded dehydroelliptone, m.p. 261–62°. The synthetic sample agreed in its properties with dehydroelliptone obtained from natural source. Further step of conversion into elliptone using sodium borohydride followed by Oppenauer oxidation has already been described by Fukami et al.[3]
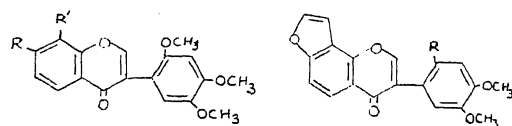
$\underline{V}$, R = OH ; R' = H

$\underline{VI}$, R = O.CH₂.CH = CH₂ ; R' = H

$\underline{VII}$, R = OH ; R' = CH₂-CH = CH₂

$\underline{VIII}$, R = OH ; R' = CH₂-CHO

$\underline{IX}$, R = OCH₃

$\underline{X}$, R = OH

$\underline{XI}$, R = O CH₂ COOCH₃

Our thanks are due to Prof. S. H. Harper for an authentic sample of dehydroelliptone.

Department of Chemistry, V. CHANDRASHEKAR.
University of Delhi, M. KRISHNAMURTI.
Delhi-7, *May* 24, 1965. T. R. SESHADRI.

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ISOLATION OF CHIKUNGUNYA VIRUS FROM *AEDES AEGYPTI* FROM CALCUTTA, INDIA

DURING the 1963 outbreak of hæmorrhagic fever in Calcutta, a large number of chikungunya virus isolations were made from the acute sera of the patients.[1] Attempts to isolate this virus from mosquitoes were not very successful and only one isolation of chikungunya virus from unidentified *Aedes* mosquitoes was reported.[2] Previously this virus has been isolated from *Aedes ægypti*, and Culex spp. in Tanganyika[3] and Thailand[4] and from *Aedes africanus* in Uganda.[5]

In 1964 a small study was undertaken in an effort to isolate chikungunya virus from wild caught mosquitoes. For this purpose two areas, where cases of chikungunya fever were occurring, were selected ; one in Howrah, and another in Calcutta proper. Mosquitoes resting inside

houses were collected in both areas. Collections were also made of mosquitoes in the act of biting man in the open in Zoological and Eden gardens in Calcutta. The mosquitoes were collected from 19 July 1964 to 6 August 1964 and from 15 September 1964 to 30 September 1964.

As these collections were composed mainly of freshly fed mosquitoes they were held in the laboratory for 24 to 36 hours at room temperature for digestion of blood. Then they were identified, pooled according to the species and stored at − 65° C. For virus isolations each pool of mosquitoes was ground in a mortar with 1·5 ml. of 0·75% bovalbumin in phosphate saline (pH 7·2) containing 1,000 units of penicillin and 1·0 mg. of streptomycin per ml. The suspensions were centrifuged at 2,000 rpm for ten minutes and supernatant fluid was inoculated intracerebrally into one litter of 2–3 days old mice. An aliquot was stored at −65° C.

Table I gives a summary of the mosquito pools tested for virus. Two virus strains were

TABLE I

Mosquito pools tested for virus in Calcutta, 1964

No.	Species		No. of pools	No. of mosquitoes
1	*Armigeres obturbans*	..	4	103
2	*Aedes ægypti*	..	11	166
3	*Aedes albopictus*	..	7	137
4	*Culex fatigans*	..	10	486
5	*Culex vishnui*	..	2	9
6	*Culex gelidus*	..	1	4
7	*Anopheles subpictus*	..	2	36
	Total	..	37	941

isolated from *Aedes ægypti* whereas pools of other species did not yield any viruses. These two strains, STM 64294 and STM 64306, were obtained from two pools of 20 *A. ægypti* collected on July 23, 1964 and July 27, 1964, respectively, from Howrah. Each isolate was identified as chikungunya virus by "quick" complement fixation test, employing 10% infected mouse brain suspension and normal and chickungunya hyperimmune mouse sera. Re-isolation attempts from the original mosquito suspensions were successful.

These results together with earlier field observations[6] and laboratory transmission experiments[7] suggest the probable role of *Aedes ægypti* in the transmission of chikungunya virus in the Calcutta outbreaks of 1963 and 1964.

Virus Research Centre,   K. R. P. SINGH.
Poona,*
and
Department of Virology,   J. K. SARKAR.
Calcutta School of Tropical Medicine,
Calcutta, *April* 24, 1965.

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CHEMICAL INVESTIGATIONS ON *CASSIA TORA* LINN.

Cassia tora (Leguminosæ) is a common herbaceous annual occurring as a weed throughout India.[1] Both the leaves and seeds constitute a valuable remedy in skin diseases.[2] The isolation of a gluciside emodin and chrysophanic acid from the seeds has been reported besides the chemical composition of its fatty oil.[3-5] As no systematic chemical investigations of the whole plant material have been reported so far, studies on the leaves and stems of the plant were undertaken.

The whole plant material in the pre-flowering stage was collected from the Institute area and properly identified. Preliminary chemical examination of the air-dried and powdered plant material indicated the presence of tannins, reducing sugars and glycosides. Analysis of total ash (10·5%) for inorganic constituents showed the presence of sulphate, phosphate, calcium, iron, magnesium, sodium and potassium.

The plant material was percolated with alcohol and the combined percolates were concentrated to a small volume and filtered. The precipitate obtained on the filter was washed with alcohol and treated with hot water. Aqueous filtrate was decolourized, concentrated and excess of methanol was added. It was allowed to cool in the refrigerator when colourless crystals adhering to the sides of the flask were obtained, which on crystallization from alcohol melted at 165°. The compound was very sweet and highly soluble in water. From its characteristic reactions and the derivatives, the compound has been identified as sugar alcohol, *d*-mannitol.

The water-insoluble residue was taken in boiling alcohol and filtered while hot. The precipitate obtained on cooling was redissolved in acetone, decolourized and treated with excess of methanol when a white compound was precipitated out. It crystallized from chloroform-methanol mixture and melted at 87°. Acetyl derivative (m.p. 72°) and the other reactions indicated the compound to be myricyl alcohol.

Alcoholic extract was further evaporated to dryness and exhausted with solvent ether. From the unsaponifiable product of the solvent ether extract was isolated a sterol melting at 137°. It yielded an acetate, m.p. 124°. The sterol was identified as β-sitosterol from the characteristic colour reactions and the derivatives.

Solvent ether-insoluble residue was treated with hot absolute alcohol and the insoluble traces of granular material gave a mixture of inorganic salts on purification. They were found to be sodium chloride and sodium sulphate. The alcohol soluble was evaporated to dryness, dissolved in water, treated with lead acetate and basic lead acetate. The filtrate was finally freed from lead, concentrated and precipitated with excess of alcohol. The hygroscopic precipitate answered the tests for carbohydrates and yielded an osazone derivative melting at 205° indicating the presence of glucose.

Division of Animal   M. S. SASTRY.
        Nutrition,
I.V.R.I., Izatnagar (U.P.), *March* 8, 1965.

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A NOTE ON THE STRUCTURE OF THE EASTERN HIMALAYAN FOOTHILLS, WEST BENGAL

THE presence of a tear fault near the line of Jaldhaka river in the Eastern Himalayan foothills of West Bengal was suspected by several geologists, although no direct field evidence for this fault was found by them. Fox (1934) wrote: "The accumulating evidence during recent years points to a great line or zone of shear faulting, of considerable horizontal movement, along a line tending from the eastern border of Sikhim in the vicinity of De Chu (Jaldhuna) river south-south-east towards Rangpur and the Jamuna channel, west of the Madhupur jungle, to the deltaic area near Barisal. Such a line of faulting would readily explain the small Lower Gondwana exposure at the western end of the Garo hills, the uplift of the Shillong plateau, the southward outlet of the Brahmaputra river, the phenomena of the older alluvium of the Madhupur jungle and, most important of all, the earthquakes which are so destructive along parts of and in the areas adjacent to this line".

During the course of detailed geological mapping of the Tertiary and Gondwana rocks exposed in the Darjeeling foothills of West Bengal by the author, field-evidence for the presence of a transverse fault near the line of Jaldhaka river was found near the emergence of the river into the plains (Fig. 1); this feature

Scale: 1" to a mile

NEOGENE
GONDWANA
DALINE
DIP (NORMAL)
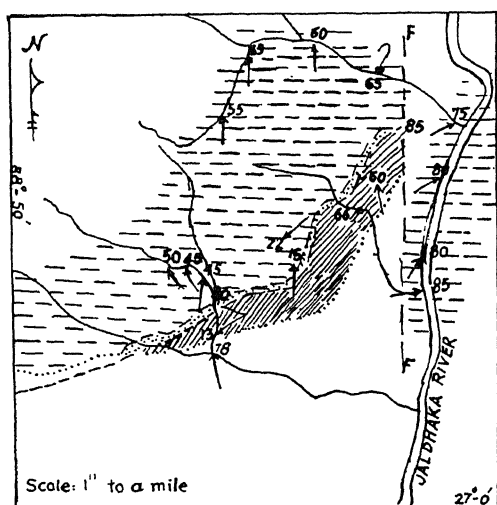DIP (OVERTURNED)
FAULT (POSITION APPROXIMATE)

was not shown earlier in the published geological maps of this area. There is a strong lateral dislocation of strata, displacing even the Main Boundary Fault, and bringing slates and phyllites of the Daling Series in the strike continuation of sandstones and shales of Neogene formations. The fault runs straight in approximately north-south direction in the area mapped and appears to be nearly vertical. It is likely to be a dextral wrench fault and the adjacent strata were involved in a considerable rotational movement, as indicated by a perpendicular bend in the strike of the Daling rocks to the east of the fault.

The Jaldhaka fault is likely to be a deep-seated feature and probably owes its origin to irregularities in the Peninsular front, against which the Himalayan rocks were pushed from the north. The gap in the exposed Tertiary belt, extending over a distance of 40 miles between Jaldhaka and Gabur Basra rivers, can be attributed to the effect of this fault and subsequent erosion. The latest movement along this fault can be postulated to have taken place during the final phase of Himalayan orogeny of Quaternary times.

The trend of this fault corresponds with the sub-meridional tectonic trends observed in the Bengal basin, *e.g.*, the north-south trend of the present geosynclinal axis of the basin, and the linear contacts of the Quaternary sediments with the Pre-Cambrian and Gondwana rocks in the west and with the Shillong plateau in the east. However, whether the Jaldhaka fault extends so far to the south as postulated by Fox, is still a matter of conjecture.

The author is grateful to Dr. D. K. Chandra, Superintending Geologist, under whose supervision the work was carried out, and to the Director of Geology, for his kind permission to publish the note.*

Directorate of Geology,   S. GANGULY. Oil and Natural Gas Commission, Dehra Dun, *November* 23, 1964.

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OCCURRENCE OF PYROPHYLLITE NEAR PATHA, JHANSI DISTRICT, UTTAR PRADESH

PYROPHYLLITE has been known to occur near Gorahiri (25° 27' : 79° 37') in Hamirpur District and near Dhankua (24° 47' : 78° 43') and Bijri (24° 42' : 78° 44') in Jhansi District. These deposits have been examined by R. C. Misra in 1944[1] and D. R. S. Mehta in 1954.[2]

The present author, while carrying out systematic geological mapping in Bundelkhand, examined the pyrophyllite deposits near Patha (25° 19' : 79° 01') and also located occurrences near Laron (25° 13' : 78° 56'), Bhadra 25° 09' : 78° 54') and Palra (25° 20' : 79° 02') in Jhansi District. These deposits occur in quartz reefs which run in a N.E.-S.W. direction through the Bundelkhand granites and gneisses. By far the major part of the area, falling in sheet No. 54 K/16, is covered with pink granite whereas the grey granites occur in subordinate amount. The granites contain a large number of inclusions of older rocks, *viz.*, epidiorites, amphibolites, hornblende-chlorite schists, garnetiferous tremolite schists and amphibolites, mica-schists, biotite-quartz granulites. Swarms of dolerite dykes are found to have been emplaced along two sets of joints in granites, running N.W.-S.E. and W.N.W.-E.S.E., and these are younger than the quartz reefs. The emplacement of quartz reefs appears to be controlled by the pre-existing joints in granites. In most cases the contact between the quartz reefs and the granite is covered with debris and alluvium.

The pyrophyllite veins occur in the quartz reefs near Patha in the form of veins running parallel to and across the trend of the reef and at places they form networks. Lenses and pockets of pyrophyllite also occur in the sheared zone of quartz reefs near the granite contact. Thin coatings of mineral have also been noticed along the joint planes. The width of pyrophyllite and quartz-pyrophyllite schist bands varies from few inches to about 15 feet. The mineral is fine-grained, light green and purple in colour and soapy to touch. Under the microscope, it is composed of patches of irregular granular aggregates and scales of kaolin, talc, iron oxide (limonite) and quartz. Analysis of a sample collected from the area reveals 63·05% of SiO_2 and 29·15% of Al_2O_3. The occurrences near Laron, Bhadra and Palra are similar to those found near Patha.

Field and laboratory studies suggest that the pyrophyllite bodies, formed by hydrothermal solutions derived from granitic magma, might be genetically connected with quartz reefs and granites. R. C. Misra[3] and A. G. Jhingran[4] were of the same opinion about its origin. The pyrophyllite mineralisation at places appears to have been controlled by shear zones present in the reefs.

The pyrophyllite deposits near Patha were worked in the past by the local people but the quarrying operations have been abandoned. The mineral is reported to have been used as a potstone in small-scale cottage industry. The good quality mineral may find use in the ceramic industry.

The work was carried out in the laboratories of the Geological Survey of India, Calcutta and Lucknow.

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Calcutta-13, *Febuary* 27, 1965.

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STRATIGRAPHIC POSITION OF THE BANDED GNEISSIC COMPLEX OF RAJASTHAN *

HERON (1953) has concluded after extensive regional mapping in Rajasthan that a first order erosional unconformity and an interval of deep erosion and peneplanation separate the Aravalli sediments from a gneissic complex, which forms the floor for sedimentation of the Aravallis and constitute the oldest rock complex of Rajasthan. He gave a stratigraphic significance to this gneiss-schist complex, and designated it as the Banded Gneissic Complex. Later workers (Sharma, 1953 ; Jhingran, 1957 ; Krishnan, 1960 ; Rama Rao, 1964) envisage that the complex is largely a product of granitisation and granitic intrusions that accompanied the Aravalli orogeny. In the chronological sequence, therefore, the gneissic complex becomes younger than the Aravallis. Rama Rao (1964) has stated in his correlation chart of the Archæan Formation of India that the basement of the Arvallis has not been definitely recognised.

The main premise of Heron's conclusion is the occurrence of a thick sequence of conglomerate-arkose-orthoquartzite at the base of the Aravalli System girdling the Banded Gneissic Complex, especially around Udaipur and Parsad. There is also a remarkable contrast in the grade of

metamorphism of the para-schist components of the Banded Gneissic Complex and that of the Aravalli sediments in the Udaipur-Parsad area. The metamorphic break broadly corresponds to the erosional unconformity. Recent work done by the author in association with R. K. Mathur in the critical areas around Udaipur and Parsad indicates that sedimentary petrological, structural and metamorphic features of the Arvallis are more consistent with Heron's interpretation.

Regionally, the Aravalli rocks in the Udaipur-Parsad area can be separated into three major groups forming north-south belts. From east to west (ignoring the Sarara inlier) these belts are : (i) a basal quartz-pebble arkosic conglomerate, arkose and orthoquartzite with local basic volcanics and insignificant dolomite ; this is an unequivocal epiclastic conglomerate containing pebbles of quartz-tourmaline rock, granite, schist, quartzite and vein quartz. The matrix of the conglomerate is arkose ; (ii) a belt in which the lithofacies changes rapidly and comprises such diverse members as ortho-quartzite, arkose, dolomite, siliceous dolomite, sub-graywacke, graded-bedded graywacke of flysch type, carbonaceous pyritic phyllite, sericite-phyllite and slates ; (iii) an entirely carbonate-free sequence of phyllite interbedded with quartzite. Basic volcanics and serpentinite intrusions have been mapped as discontinuous bodies separating lithofacies No. 2 from lithofacies No. 3. Broadly, the attributes of the three groups respectively conform to those of the sediments deposited in near-shore littoral belt, unstable shelf and deep sea environment. Thus, a preliminary analysis of the sedimentalogical features leads independently to a conceptual model of a pre-Aravalli landmass, formed probably of the Banded Gneissic Complex. This landmass must have covered a part of the Mewar plain but its geographical extent cannot be demarcated from the data available.

It is logical to assume that the basement of the Aravalli sediments was also involved in the Aravalli orogeny and was mobilised in varying degrees in different parts of the Aravalli geosyncline. The unconformable contact has consequently been modified by deformation, metamorphism and by intrusive magmatic activity at places. The presence of localised evidences of intrusive relationship (assuming these are present) between the Aravallis and the Banded Gneissic Complex, therefore, does not necessarily lead to the sweeping generalisation that the Banded Gneissic Complex is in toto a post-Aravalli rock formation.

The Banded Gneissic Complex, as shown in the published maps, covers a large area of Rajasthan and possibly comprises granites and gneisses of different ages having different field relationship with the metasediments. Detailed mapping and geo-chronological work is essential to classify the granites and to correlate them with various orogenic cycles. However, in the Udaipur and Parsad area, at least, the basement of the Aravalli rocks is clearly recognisable.

The author is thankful to Shri C. S. Raja Rao, Superintending Geologist, Geological Survey of India, under whose guidance remapping of important areas is being conducted.

Geological Survey of India,   B. C. PODDAR.
Bairathi Bhawan,
Prithviraj Marg,
Jaipur, *January* 28, 1965.

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* Published by the kind permission of the Director-General, Geological Survey of India.

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FOSSIL WOOD OF *LAGERSTROEMIA* FROM THE TERTIARY OF BURMA

A NEW fossil wood belonging to the genus *Lagerstroemia* is recorded here from the Tertiary of Burma based on material sent to the late Professor Birbal Sahni by a Rangoon University botanist in 1934. The fossil wood is represented by a small piece of decorticated secondary xylem and shows the following characters :

Growth rings distinct, delimited by narrow line of terminal parenchyma (Fig. 1) and the large spring wood vessels. *Vessels* large to medium-sized or small, largest in the inner portion of the ring, grading more or less gradually into smaller vessels, t.d. 105–270 μ, r.d. 105–370 μ, solitary as well as in radial multiples of 2-3 or 4 cells, round to oval in cross-section, 6-11 per sq. mm. ; vessel-members short, usually with truncate ends ; perforations simple ; intervessel pit-pairs vestured, alternate to sub-opposite, 6-8 μ in diameter with horizontal linear-lenticular apertures ; tyloses abundant. *Parenchyma* paratracheal and apotracheal

(Fig. 1); paratracheal parenchyma quite abundant occurring as vasicentric sheath round some of the spring wood vessels, becoming aliform to aliform-confluent farther out in the
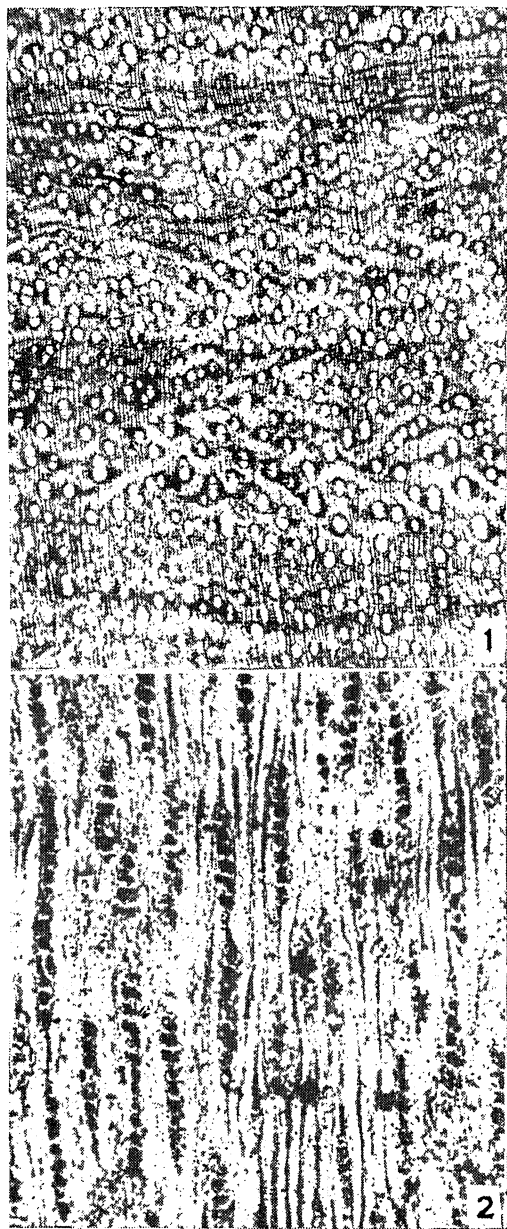
FIGS. 1-2. *Lagerstroemioxylon parenchymatosum* sp. nov. Fig. 1. Cross section showing vessel distribution and parenchyma pattern, × 8. Fig. 2. Tangential longitudinal section showing the xylem rays, × 100.

ring, forming long bands in the outer part of the late wood; the apotracheal type diffuse occurring as solitary or in groups of

cells and in narrow terminal bands at the growth rings; cells sometimes crystalliferous. *Xylem rays* mostly uniseriate, occasionally biseriate (Fig. 2), close, 13-18 per mm.; ray tissue homogeneous with rays composed of procumbent cells. *Fibres* semilibriform, slightly thicker-walled with big lumina, septate, and polygonal in cross-section; sometimes crystalliferous.

The structural features of this fossil wood indicate that the closest resemblance of the fossil is with the genus *Lagerstroemia* of the family Lythraceæ (Metcalfe and Chalk, 1950; Pearson and Brown, 1932), although it also shows some resemblance to the mature secondary xylem of *Terminalia crenulata*. However, the parenchyma pattern and the presence of crystalliferous fibres in the present fossil wood distinguish this fossil from that of *T. crenulata*.

As the present fossil wood resembles the modern genus *Lagerstroemia* in all anatomical details, it is being assigned to the form genus *Lagerstroemioxylon* Madler (1939) and recorded as a new species, *L. parenchymatosum*. It differs markedly from its only known species, *L. durum* Madler (1939) from the Pliocene of Frankfurt.

Birbal Sahni Institute of   U. PRAKASH.
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MODE OF CELL-DIVISION IN THE ARCHESPORIAL CELLS IN *MARCHANTIA PALMATA* NEES

PROFESSOR IYENGAR (1960) studied the cell-division and cross-wall formation in various algæ, particularly in *Cylindrocapsopsis indica* Iyengar, *Binuclearia tectorum* (Kütz.) Beger and the unicellular alga *Ecballocystopsis indica* Iyengar which developed a filamentous habit as a secondary condition. He found in all these cases that during cell-division, the daughter-cells were not separated by any membrane or cell-plate but that each daughter-cell protoplast surrounded itself with a wall of its own inside the mother-wall, and for some time, the two daughter-cells remained within the stretched wall of the parent cell. Iyengar (1960) thus confirmed the views put forth in these respects by Pascher (1924, 1930).

At the kind suggestion of the late Prof. Iyengar, the author collected *Marchantia palmata* Nees from Ootacamund (South India) to study the conditions obtained in this liverwort. The sporogonia were fixed in FAA and properly stained smears of the archesporial cells in various stages of development were made.

After the nucleus of the mother-cell first divides, the protoplast of the cell gets cleaved from the peripheral region (Figs. 4, 7). The furrow deepens and finally the cell is divided into two portions (Figs. 1–7). As the protoplast divides by furrowing, new and very delicate walls are seen formed at the "isthmus" region also, covering the otherwise naked surface of the dividing protoplast (Figs. 4, 7). As further development takes place, a few more layers of walls are formed in succession surrounding the daughter protoplasts. The wall of the mother-cell generally gets distended and remains thin as the daughter-cells grow and increase in size. The distended mother-cell-wall also keeps pace with the elongation and division of several generations of daughter-cells, the walls of the respective generation of mother-cells remaining distinctly visible (Figs. 2–4, 5, 7). Further divisions occur in the resulting cells likewise in the same plane repeatedly, three or more times, giving rise to eight or more daughter-cells occurring in a row. Occasionally, however, the division of a cell may be in a plane at right angles to the earlier division (Figs. 2, 6). Generally the daughter-cells formed by one mother-cell remain close to each other, still showing very clearly the layers of walls surrounding the individual cells. In some cases, however, the cells get distended and remain quite apart when the stratifications of the wall in between are more distinctly seen (Fig. 5). Ultimately, however, when the spore-mother-cells result from these divided archesporial cells, the mother-walls get dissolved and each spore-mother-cell, with its own individual cell-walls, remains quite distinct and separate.

In a rare and exceptional case, in *Dumortiera hirsuta* Reinw. Bl. et Nees from Kodaikanal Hills in South India, the author found among the normal spore-tetrads, a group of five spores attached end to end in a row (Srinivasan, 1945). These would seem to represent a row of spore-mother-cells formed by one of the original elongated sporogenous cells. These five spore-mother-cells, unlike the normal spore-mother-cells, have failed to divide into tetrads of spores, but have remained still attached to one another

in a row, and their walls also developing the characteristic sculpturing of the normal spore.
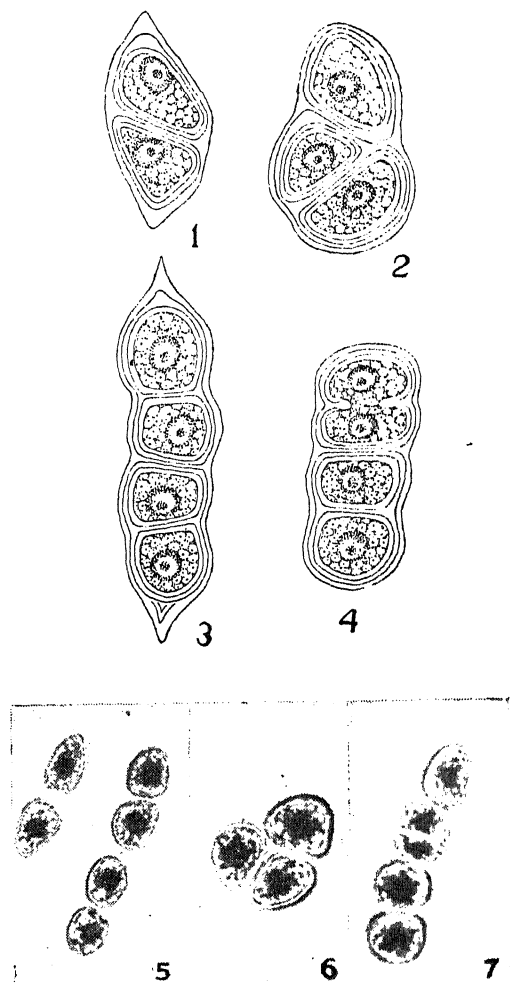
FIGS. 1–7. *Marchantia palmata* Nees. Archesporial cells showing division and cell-wall formations. Figs. 1–4, × 650; Figs. 5, 7, × 280; Fig. 6, × 385.

Thus in *Marchantia palmata* Nees, during cell-division in the archesporial cells, the daughter-cells are not separated by any membrane or cell-plate connected with the mother-cell-wall, but the two daughter-cells result by furrowing, and each resulting protoplast developing around it, its own walls. In this, it agrees with the observations recorded in the case of several algæ by Pascher (1924, 1930), Iyengar (1960) and Elliot (1951) who examined by maceration techniques, among various groups of plants, stems of *Sphagnum* and thallus of *Lunularia* in Bryophyta.

Curator, Industrial Section,   K. S. SRINIVASAN.
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VARIATIONS IN THE CONIDIAL MORPHOLOGY OF *PESTALOTIOPSIS DARJEELINGENSIS* IN CULTURE

DUBE *et al.* (1964) reported this fungus from Darjeeling on the leaves of *Quercus incana*. Another species, *viz.*, *P. clavispora* (Akt.) Stey., was recorded earlier on this host as *Pestalotia clavispora* Akt. by Mundkur and Kheshwalla (1942). The conidia of *P. darjeelingensis* when recovered from the diseased leaves are invariably clavate and five-celled, measuring 23·4–31·2 × 7·8–10·4 μ. They are further characterized by the presence of three olive intermediate cells, long filiform pedicel below the inferior hyaline cell and 4 to 8 setulæ measuring 20·8 to 52 μ over the superior hyaline cell.

Detailed cultural behaviour of the fungus was studied on Potato-dextrose agar slants. The conidial dimensions in culture varied from 1·2 to 42·2 × 7·1 to 9·1 μ while the length of the setulæ ranged from 10·4 to 20·0 μ. The shapes of various types of conidia obtained in culture are given in Fig. 1.

It is evident from Fig. 1 that the number of cells in the conidia varied from four to eight. Their percentage was as follows: four-celled 16%, five-celled 70%, six-celled 10% and eight-celled 4%. They were always characterized by the presence of superior and inferior hyaline cells and intermediate coloured cells. The conidial shape varied considerably. They were cylindrical, elliptic, clavate, elliptic-fusiform or clavate-fusiform. In several cases the size of the intermediate coloured cells did not show any uniformity. The superior hyaline cells always possessed elongated hyaline setulæ which showed considerable variations in their number as well as length. The inferior hyaline cells usually possessed short or long pedicel. These studies show that average conidial length

was increased in culture, while the length of the setulæ was considerably reduced. The investigations impress upon the desirability of studying the role of various host-ingredients on conidial morphology of *P. darjeelingensis.*
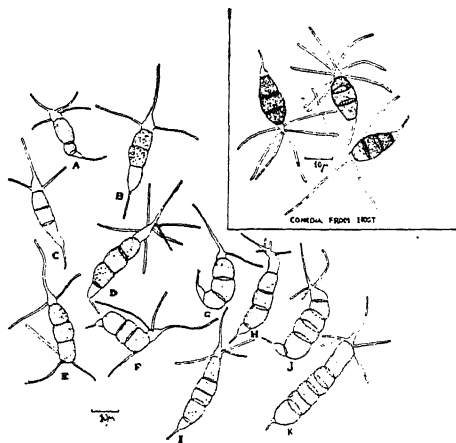
FIG. 1. A–C. Various types of four-celled conidia. D–H. Various types of five-celled conidia. Few conidia possess setulæ on both superior and inferior hyaline cells (E). I, J. Showing elliptic-fusiform and clavate-fusiform six-celled conidia respectively. I, K. Eight-celled conidia.

Department of Botany,   H. C. DUBE.
University of Allahabad,   K. S. BILGRAMI.
December 28, 1964.

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SCLEREIDS IN THE RIND OF A *CITRUS* HYBRID

THE plant under investigation is growing in the *Citrus* Orchard of Nani Agricultural Institute, Allahabad and was collected by (Late) Prof. W. B. Hayes. It flowers only once a year in late winters and the flowers though white are smaller than the normal pummelo flowers. The fruits are very large like sour pummelo. The juice is not very sweet and has the flavour of *Limonia acidissima*. The most peculiar feature of this hybrid is the brown-coloured inner side of the rind (Fig. 1-*a*). In between these brown areas there is a comparatively thin layer of lighter colour (Fig. 1-*b*). This layer is also very hard. The sections passing through brown

zones show large groups of sclereids (Figs. 2, 3) and vascular bundles with large amount of xylem tissue. These sclereids are also present in thin hard layers (Fig. 1-b). It is the abundance of these sclereids that gives so much hardness to the rind.
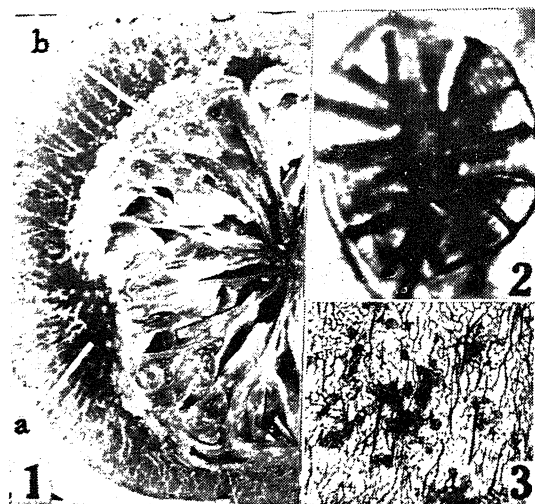
FIGS. 1-3. Fig. 1-:. Brown-coloured zone of hardness in the rind. Fig. 1-*b*. A layer of hard tissue. Fig. 2. A sclereid highly magnified. Fig. 3. Groups of sclereids.

The chromosome number of this hybrid has been found to be $2n = 18$, which is the diploid number for genus *Citrus*.[2-4,6-7] Meiosis of this hybrid exhibits very few anomalies.

This presumably is the first record of presence of large groups of sclereids in the rind of any *Citrus* fruits. The previous workers[1,8] have not reported any sclereids. Prof. F. M. Scott studied the rind of many varieties of *Citrus* growing in the University experimental orchards in Los Angeles and River-side but he never came across any stone cells (personal communication). On the basis of morphological characters this tree appears to be a hybrid between *Citrus limonia* and *C. grandis*. But both these species do not possess such large groups of stone cells in their rind. The two genera *Limonia acidissima* Linn. and *Aegle marimelos* of Rutaceæ have stony covering of the fruits. These genera are distantly related to genus *Citrus*. Till now there is no record of hybrids of *Citrus* with so distantly related genera; of course *Citrus* hybridizes without much difficulty with its nearly related genera like *Poncirus trifoliate* and *Fortunella*. Rusk citrange, one such intergeneric hybrid between *Citrus* and *Poncirus trifoliate*, shows fairly regular bivalent

formation.[5] This indicates that large segments of *Citrus* chromosomes are homologous with *Poncirus*.

Some of the important characters of this hybrid like the presence of large groups of sclereids in the rind and flavour of juice indicates a possible relationship with *Limonia acidissima*. The chromosome number of *Limonia acidissima* is also eighteen.[9] But then this hybrid shows homology between its chromosomes and mostly bivalents are formed. The high percentage of pollen fertility is further evidence of its stable state. It is quite possible that intergeneric hybridization between *Citrus* and some other genus having large groups of stone cells in its rind followed by backcrossing with *Citrus* may have brought back most of the characters of *Citrus* but some of the characters of other genus may have persisted due to certain segmental exchanges between the chromosomes of these two genera during the meiosis in the intergeneric hybrid. That pairing between chromosomes takes place when *Citrus* hybridizes at least with its nearly related genera has already been reported.[5]

Cytogenetics Lab., S. S. RAGHUVANSHI.
Dept. of Botany, Univ. of Lucknow,
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OCCURRENCE OF TRUFFLE DISEASE (*PSEUDOBALSAMIA MICROSPORA* DIEHL AND LAMBERT) IN MUSHROOM BEDS

DURING the course of experimentation on mushroom cultivation at Plant Pathology Laboratory, Solan, Himachal Pradesh, H. S. Sohi, P. K. Seth and S. Kumar observed a very heavy incidence of the Truffle disease caused by *Pseudobalsamia microspora* Diehl and Lambert in the bearing trays of *Psalliota bispora* (Lange) Moller and J. Schaffer in the last week of April 1964. The disease first appeared when the temperature of the compost in the trays reached beyond 70° F. During initial stages of the disease, the infected trays produced some

mushrooms but subsequently stopped bearing altogether as the incidence of the disease increased further. The spread of the disease was very rapid and was favoured by high temperatures during the months of May and June.

The disease is considered to be one of the most serious diseases of mushroom compost in some foreign countries and is also known as 'Calves Brains'. In the infected trays where truffle had developed, the mushroom mycelium rapidly disappears and the compost generally turns dark brown with a shaggy appearance emitting a characteristic chlorine-like odour. The surface of the compost was ultimately covered with thick whitish fungal growths.
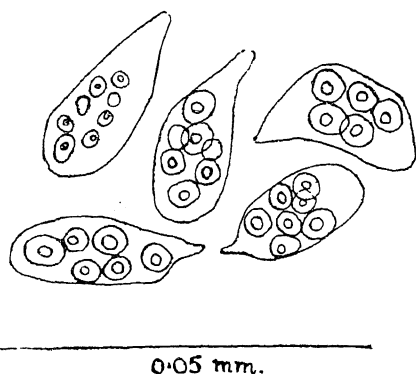

0·05 mm.

FIG. 1. Mature asci showing irregularly arranged spores.

Symptoms.—The disease manifests itself as small wefts of white to cream-coloured mycelium on the surface of the casing soil or in the compost, gradually the mycelium becomes thicker and develops into white, solid, wrinkled, rounded to irregular masses resembling small brains, varying in length from a mm. to one and one half inch or sometimes more. These are the fruiting bodies or ascocarps of the fungus.

Ascocarps fleshy, sub-spherical to irregular, with a cerebriform surface, whitish to cream-coloured in the initial stages, ultimately reddish-brown when mature, lobed, infolded at the base when appearing on the substratum and contain numerous asci which are arranged irregularly in the fruit bodies.

Asci oval to sub-spherical, short or long stipitate, 3–8 spored, $19 \cdot 3$–$27 \cdot 9 \times 10 \cdot 7$–$15 \cdot 0 \, \mu$.

Ascospores sub-spherical, sulphur-coloured, usually with one distinct oil-drop, $5 \cdot 3$–$6 \cdot 4 \, \mu$ in diameter.

Paraphyses reduced to anastomosing hyphæ $4 \cdot 7 \, \mu$ in diameter.

Control.—Since the ascospores of this fungus were able to survive a temperature of 82° C. (180° F.) for a period of 5 hours and were resistant to all fungicides which are commonly used for disease control, some other cultural methods were tried for the control of the disease. The disease could be kept under check when the temperature of the compost was maintained below 62° F. as the spores of this fungus usually did not germinate at this temperature. Even if some of these germinate, the mycelium could not grow further and no fructifications were formed. Further studies are in progress.

The disease has so far been reported from U.S.A. and U.K. This is the first record of this fungus from India.

Plant Pathology Laboratory,   H. S. Sohi.
Department of Agriculture,   P. K. Seth.
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FUNGAL FLORA OF TWO SOILS AT TIRUPATI

A RED sandy soil, low in clay content and organic matter fraction, is the predominant type in Chittoor District (Satyanarayana and Sankaram, 1955) but irrigated fields in the area contain black clay soil which is frequently mixed with the red soil to increase its fertility. An examination of the two soils by the Rossi-Cholodnys' contact slide technique revealed that only bacteria were active in the red soil while fungi and actinomycetes were also abundant in the black soil. As large variation in fungal population is indicative of differences in soil fertility (Zoffe, 1963) an investigation of fungal flora of the above soils was undertaken.

A few important properties of the soils, together with methods used for their determination, are given in Table I. The medium used

TABLE I
Characteristics of the soils employed

Property	Method of determination	Value	
		Red soil	Black soil
pH of soil solution	Glass-calomel electrode pH meter	6·5	6·1
Organic matter content	Loss of weight on dry ignition	1·84% ±0·07%	7·96% ±0·17%
Moisture-holding capacity	Perforated box method	35%	52%
Moisture content (at the time of setting up of experiments)	do.	5% m.h.c.	24% m.h.c.
Fungal population	Dilution plate method	9,760	4,50,000

for estimation and isolation of the fungi is Czapek-Dox + yeast extract agar with 40 μg./ml. rose bengal and pH adjusted to 4·0 to render it bacteriostatic.

Fungi were isolated from serial dilution plates and from plates prepared by a modified method (Rao, 1962) in which soil was mixed with agar medium directly so as to allow the hyphæ adhering to soil particles and getting lost when dilutions are prepared in water to develop on plates. The isolates were identified with the help of treatises on soil fungi (Raper and Thom, 1949 ; Gilman, 1957) and the lists checked up with records of Indian soil fungi (Butler and Bisby, 1960 ; Subramanian, 1952).

The following fungi were isolated from both the soils : *Cunninghamella echinulata* Thaxter, *Neocosmospora vasinfecta* E. F. Smith, *Cephalosporium* sp., *Aspergillus flavus* Link, *A. nidulans* (Eidam) Winter, *A. niger* van Tieghem, *A. terreus* Thom, *A. ustus* (Bain.) Thom and Church, *Penicillium citrinum* (series), *Gliocladium fimbriatum* Gilman and Abbott, *Pœcilomyces varioti* Bainier, *Scopulariopsis brevicaulis* Bainier, *Fusarium* spp., *Rhizoctonia* sp. and sterile forms (both hyaline and dark-coloured). Fungi isolated from the red soil alone are *Mucor hiemalis* Wehmer, *Cephalosporium acremonium* Corda, *Aspergillus luchuensis* Inui, *A. fumigatus* Fres., *A. versicolor* (Vuill.) Tiraboshi, *Penicillium spinulosum* Thom, *Staphylotrichum coccosporum* Nicot and Meyer, *Curvularia pallescens* Boedijn and *Alternaria humicola* Oudemans. The following forms were found in the black soil : *Mucor silvaticus* Hagem, *M. bacilliformis* Hassel., *Syncephalastrum racemosum* (Cohn) Schr., *Pestalotia* sp., *Cephalosporium roseogriseum* Saksena, *Aspergillus candidus* Link, *A. sulphureus* (Fres.) Thom and Church,

A. sydowi (Bain. and Sait.) Thom and Church, *Penicillium vinaceum* Gilman and Abbott, *P. luteum* Zukal, *Trichoderma viride* Pers. ex Fries, *Spicaria simplicissima* Oudemans and *Memnoniella echinata* (Riv.) Galloway.

The two soils showed characteristic mycoflora with hyaline forms predominating in the black soil while dark-coloured forms were very numerous in the red soil. Aspergilli accounted for 60–80% of total population in both the soils but species distribution was distinct with *niger* and *terreus* groups dominating the red soil while *A. sulphureus* and *A. candidus* being more frequent in the latter. Occurrence of *S. coccosporium* and *Pestalotia* sp., which are active cellulose decomposers, in the black soil is of practical interest in view of high organic matter content of it. Dark-coloured forms are known to be more tolerant to high temperatures (Nicot, 1960) and their prevalence may be related to low moisture and exposure of the red soil to sunlight with consequent increase in temperatures. The very wide difference in fungal population of the two soils appears to support the local belief that the black soil is more fertile than the red soil.

This study resulted in the isolation of *Penicillium spinulosum* Thom, *Penicillium vinaceum* Gilman and Abbott, *Spicaria simplicissima* Oudemans, *Gliocladium fimbriatum* Gilman and Abbott and *Staphylotrichum coccosporium* Nicot and Meyer for the first time in India. Fungi reported for the first time from Indian soils are : *Mucor silvaticus* Hagem, *Penicillium citrinum* (series), *Pestalotia* sp. and *Cephalosporium* spp.

I thank Dr. J. C. F. Hopkins, erstwhile Director of Commonwealth Mycological Institute, Kew, England, for identifying *P. luteum*, *P. vinaceum* and *S. coccosporium*.

Department of Botany,   A. S. RAO.
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REVIEWS AND NOTICES OF BOOKS

Histological Techniques for Electron Microscopy (Second Edition). By Daniel C. Pease. (Academic Press, New York and London), 1964. Pp. xv + 381. Price $ 9.50.

The first edition of this book was published in March 1960. The present second edition was necessitated by the introduction of thermostable plastics as embedding media—an advance that has begun a revolution that is still in process. It is a much richer methodology than before, for it includes in addition to new embedments, new ways of preserving specimens, new stains, and such ancillary techniques as "negative staining", autoradiography, and conjugated antibody staining. These, as well as all aspects introduced in the past four years, are treated in this new edition. Standard methods defined in the first edition have been retained. References, of course, have been greatly expanded.　　　　　C. V. R.

Physical Properties of Magnetically Ordered Crystals. By E. A. Turov. (Academic Press, New York and London), 1964. Pp. xx + 222. Price $ 10.00.

The primary aim of this book is to consider a wide range of various physical phenomena in ferromagnets and antiferromagnets using a unified phenomenological method based on the spin-wave theory, the nature of these phenomena, and the symmetry properties of crystals. Within the framework of this phenomenological method, the author attempts to establish qualitative and quantitative relationship which reflect the fundamental connections between the different effects in ferromagnets and antiferromagnets. Also within this same methodological framework, a complete, systematic treatment of effects related to weak ferromagnetism in antiferromagnetic crystals is given.　C. V. R.

Physiological Mammalogy (Vol. II)—*Mammalian Reactions to Stressful Environment.* Edited by. William Mayer and Richard Van Gelder. (Academic Press, New York and London), 1964. Pp. xii + 326. Price $ 11.50.

Volume I of this treatise was reviewed earlier in *Current Science.* The present volume continues to emphasize the less-studied 'wild'

mammal in order to make available to the mammalogist, physiologist, ecologist, and behaviorist the wealth of data found in the widely scattered works of research scientists of diverse experimental interests.

This volume consists of three comprehensive articles, *viz.,* (1) Reproduction and Development, by S. A. Asdell; (2) Water Metabolism of Mammals, by Robert M. Chew; and (3) Hibernation, by Ch. Kayser.

Both experimental animal biologists and those who work with mammals in any capacity will find this volume of great value in their studies.　　　　　　　　　C. V. R.

Evolutionary and Genetic Biology of Primates. (Vols. I and II). Edited by John Buettner-Janusch. (Academic Press, New York and London).

Volume I, 1963. Pp. xiv + 327. Price $ 12.00.
Volume II, 1964. Pp. xii + 330. Price $ 12.50.

These two volumes contain an extensive survey of contemporary research on the Primates, including much hitherto unpublished material as well as new work.

Volume I contains the following articles : (1) An Introduction to the Primates, by John Buettner-Janusch ; (2) A Critical Reappraisal of Tertiary Primates, by Elwyn L. Simons ; (3) The Primate Nervous System : Functional and Structural Aspects in Phylogeny, by Charles R. Noback and Norman Moskowitz ; (4) New Approaches to the Study of the Skin of Primates, by William Montagna and Richard A. Ellis ; (5) The Sweat Glands of the Lorisidæ, by Richard A. Ellis and William Montagna ; (6) Nerve Endings in the Skin of Primates, by R. K. Winkelmann ; and (7) The Chromosomes of Primates, by M. A. Bender and E. H. Y. Chu.

Volume II contains the following articles : (1) Susceptibility of Primates to Viruses in Relation to Taxonomic Classification, by G. D. Hsiung, F. L. Black and J. R. Henderson ; (2) Immunochemical Analysis of Serum Proteins of the Primates : A Study in Molecular Evolution, by C. A. Williams, Jr. ; (3) Hemoglobins of Primates, by John Buettner-Janusch and Vina Buettner-Janusch ; (4) Reproductive Physiology and Behavior of the Lemuroidea, by A. Petter Rousseaux ; (5) Use of the Hand in Lower

Primates, by Alison Bishop; and (6) The Displays of the Primates, by R. J. Andrew.

C. V. R.

Progress in Nucleic Acid Research and Molecular Biology (Vol. 3). (Academic Press, New York and London), 1964. Pp. xiv + 363. Price $ 11.50.

This volume under review reflects the continuing and rapid progress in the field of nucleic acid research and molecular biology. It integrates discussions and provocative speculations written by acknowledged experts in the varied disciplines concerned with this field. The contributions are within the specific, circumscribed areas in which each author is an authority.

The articles contained in this book and their respective authors are given below: Isolation and Fractionation of Nucleic Acids, by K. S. Kirby; Cellular Sites of RNA Synthesis, by David M. Prescott; Ribonucleases in Taka-Diastase: Properties, Chemical Nature, and Applications, by Fujio Egami, Kenji Takahashi, and Tsuneko Uchida; Chemical Effects of Ionizing Radiations on Nucleic Acids and Related Compounds, by Joseph J. Weiss; The Regulation of RNA Synthesis in Bacteria, by Frederick C. Neidhardt; Actinomycin and Nucleic Acid Function, by E. Reich and I. H. Goldberg; De Novo Protein Synthesis *in vitro*, by B. Nisman and J. Pelmont; Free Nucleotides in Animal Tissues, by P. Mandel.

C. V. R.

The Physiology of Insecta (Vol. III). Edited by Morris Rockstein. (Academic Press, New York and London), 1964. Pp. xiv + 692. Price: List Price $ 25.00; Subs. Price $ 22.50.

Volumes I and II of this comprehensive treatise have already been reviewed earlier in *Current Science*. The present volume continues the treatment of the reactions of the insect in relation to its environmental homoeostatic state.

This volume consists of eleven articles whose titles and their respective authors are as given below: (1) The Circulatory System of Insects, by Jack Colvard Jones; (2) Hemolymph: Composition, by Marcel Florkin and Ch. Jeuniaux; (3) Hemolymph Coagulation, by Ch. Gregoire; (4) Salt and Water Balance: Excretion, by R. H. Stobbart and J. Shaw; (5) Immunological Responses, by John D. Briggs; (6) The Physiology of Insecticide Resistance by Insects, by Albert S. Perry; (7) The Structure and Forma-

tion of the Integument in Insects, by Michael Locke; (8) Chemistry of the Insect Cuticle, by R. H. Hackman; (9) The Permeability of Insect Cuticle, by Walter Ebeling; (10) Respiration—Aerial Gas Transport, by P. L. Miller and (11) Respiration: Some Exogenous and Endogenous Effects of Rate of Respiration, by Margaret Keister and John Buck.

C. V. R.

Hormonal Steroids : *Biochemistry, Pharmacology and Therapeutics* (Vol. 1). Edited by L. Martini and A. Pecile. (Academic Press, New York and London), 1964. Pp. xx + 587. Price $ 18.00.

This volume contains the Proceedings of the First International Congress on Hormonal Steroids.

A total of six symposia on the following topics are reported in this book: (1) New Steroids with Hormone-like Activities; (2) Pathways of Synthesis and Metabolism of Hormonal Steroids; (3) Control of Synthesis and Release of Steroid Hormones; (4) Mechanism of Steroid Action; (5) Substances which Affect Synthesis and Action of Steroid Hormones and (6) Nonhormonal Activities of Steroids. The number of articles given under each symposium are eleven, eight, twenty-one, ten, ten and fourteen respectively.

In all one hundred and five authors have contributed to this volume.   C. V. R.

International Review of Neurobiology. Edited by Carl C. Pfeiffer and John R. Smythies. (Academic Press, New York and London).
Volume 5, 1963. Pp. xi + 439. Price $ 14.00.
Volume 6, 1964. Pp. xi + 476. Price $ 15.00.
Volume 7, 1964. Pp. ix + 368. Price $ 13.00.

Volume 5 of this series contains the following articles: The Behaviour of Adult Mammalian Brain Cells in Culture, by Ruth S. Geiger; The Electrical Activity of a Primary Sensory Cortex: Analysis of Ecg Waves, by Walter J. Fretman; Mechanisms for the Transfer of Information along the Visual Pathways, by Koiti Motokawa; Ion Fluxes in the Central Nervous System, by F. J. Brinley, Jr.; Interrelationships between the Endocrine System and Neuropsychiatry, by Richard P. Michael and James L. Gibbons; Neurological Factors in the Control of the Appetite, by Andre Soulairac; Some Biosynthetic Activities of Central Nervous Tissue, by R. V. Coxon; Biological Aspects of Electroconvulsive Therapy, by Gunnar Holmberg.

Volume 6 contains the following articles: Protein Metabolism of the Nervous System, by Abel Lajtha; Patterns of Muscular Innervation in the Lower Chordates, by Quentin Bone; The Neural Organization of the Visual Pathways in the Cat, by Thomas H. Meikle, Jr., and James M. Sprague; Properties of Afferent Synapses and Sensory Neurons in the Lateral Geniculate Nucleus, by P. O. Bishop; Regeneration in the Vertebrate Central Nervous System; Neurobiology of Phencyclidine (Sernyl), a Drug with an Unusual Spectrum of Pharmacological Activity, by Edward F. Domino; Free Behavior and Brain Stimulation, by Jose M. R. Delgado;

Volume 7 contains the following articles: Alteration and Pathology of Cerebral Protein Metabolism, by Abel Lajtha; Micro-Iontophoretic Studies on Cortical Neurons, by K. Krnjevic; Responses from the Visual Cortex of Unæsthetized Monkeys, by John R. Hughes; Recent Developments of the Blood-Brain Barrier Concept, by Ricardo Edstrom; Monoamine Oxidase Inhibitors, by Gordon R. Pscheidt; The Phenothiazine Tranquilizers: Biochemical and Biophysical Actions, by Paul S. Guth and Morris A. Spirtes; Comments on the Selection and Use of Symptom Rating Scales for Research in Pharmacotherapy, by J. R. Wittenborn; and Multiple Molecular Forms of Brain Hydrolases, by Joseph Bernsohn and Kevin D. Barron.

C. V. R.

Techniques in Endocrine Research. Edited by Peter Eckstein and Francis Knowles. (Academic Press, New York and London), 1963. Pp. xvi + 319.

This volume is a report of the Proceedings of a Nato advanced study Institute held in Stratford-Upon-Avon, England, under the auspices of the University of Birmingham. Twenty-one authors contribute to this book. Three leading articles are (1) Inaugural Lecture on Present Perspectives in Endocrinology, by E. C. Amoroso, (2) X-Ray Crystallography in Hormone Research, by Dorothy Crowfoot Hodgkin and (3) The Separation and Significance of Hormone-containing Sub-Cellular Particles, by U. S. von Euler. Other articles deal with the various techniques adopted in endocrine research. Amongst them may be mentioned the following: Autoradiography in Endocrine Research; Chromatographic Methods of Separation; Immunochemical Methods; Transplantation of Endocrine Organs; Preservation and Storage of Endocrine Tissue; and Experimental Control of Ovum Implantation.

C. V. R.

Metabolic Inhibitors, A Comprehensive Treatise (Vol. II). Edited by R. M. Hochster and J. H. Quastel. (Academic Press, New York and London), 1963. Pp. xviii + 753. Price: Regular $29.00; Subs. $24.00.

This book is the second volume of a two-volume treatise on Metabolic Inhibitors. The subject in this volume is dealt with in twenty-three chapters whose titles are as follows: Dinucleotide Analogues and Related Substances; Antibiotics; Monoamine and Polyamine Analogues; Inhibitors of Catechol Amine Metabolism; Sulfhydryl Agents; Arsenicals; Mercaptide-Forming Agents; Enzyme Inhibition by Quinones; Biological Alkylating Agents; Inhibition of Acetylcholinesterase, Organophosphates and Carbamates; Herbicides; Fungicides as Metabolic Inhibitors; Trypanocidal Agents; Cations and Anions: Inhibitions and Interactions in Metabolism and in Enzyme Activity; Polyanionic Inhibitors; Inhibitions in the Citric Acid Cycle; Uncouplers and Inhibitors of Oxidative Phosphorylation; Effects of Anesthetics, Depressants, and Tranquilizers on Cerebral Metabolism; Inhibitors of Gas Transport; Selective Inhibitors of Photosynthesis; Inhibitors of Nitrogen Fixation; Inhibitors of Nitrification; and Inhibition Due to Radiation.

C. V. R.

Solid State Physics—Advances in Research and Applications (Vol. 16). Edited by Frederick Seitz and David Turnbull. (Academic Press, New York), 1964. Pp. xvi + 446. Price $15.50.

Volume 16 of the series *Solid State Physics* contains four articles. The first article on "Cohesion of Ionic Solids in the Born Model" by M. P. Tosi is a comprehensive review on the subject and includes discussions and results on cohesive energy, ionic radii, and surface energy. The second article is on "F-Aggregate Centres in Alkali Halide Crystals" by W. D. Compton and H. Rabin. In investigations on colour-centre phenomena in alkali halide crystals, the F-centre has been the focal point of research because it gives rise to the most prominent optical absorption band and also is easily amenable to experimental and theoretical studies. The family of centres giving rise to optical absorption bands on the long wavelength side of the F-band have received much less attention. Recent researches on these complex centres known as F-aggregate centres, their formation and characteristics are surveyed in this article.

The third article is by M. T. Hutchings on "Point-Charge Calculations of Energy Levels of

Magnetic Ions in Crystalline Electric Fields" and in the last article on "Physical Properties and Interrelationships of Metallic and Semi-metallic Elements" K. A. Gschneidner presents an extensive compilation of data on elastic and thermal properties of the elemental metals and semiconductors and their interrelationships.

A. S. G.

Survey of Progress in Chemistry (Vol. 2). Edited by Arthur F. Scott. (Academic Press, New York), 1965. Pp. xii + 345. Price $ 7.95.

The first volume of this series was reviewed in the August 5, 1964 issue of this Journal (*Current Science*, 1964, 33, 599). As mentioned there, this survey series is primarily intended for the college chemistry teacher as an aid to maintain the standard of teaching against the background of rapidly developing researches in various fields of chemistry. In institutions and colleges where graduate teaching and post-graduate research go together it may be possible for a college teacher to keep himself in the know of current research, but where teaching and research are separate, as happens in many cases, the teacher is handicapped to keep abreast of the steadily increasing flow of new ideas, and consequently instruction steadily lags behind current research.

This series has been launched to overcome this difficulty by acting as a medium of transmission of new material to the College chemistry teacher.

The present volume contains the following articles : Mechanisms of Substitution Reactions of Metal Complexes, by F. Basolo; Fast Reactions in Solutions, by E. M. Eyring ; Fused Salt Chemistry, by J. D. Corbett ; Equilibria in Concentrated Mineral Acid Solutions, by N. C. Deno ; Nucleophitic Displacement Reactions at the Sulphur-Sulphur Bond, by R. E. Davis ; and The Mechanisms of Some Photochemical Reactions of Organic Molecules, by J. Saltiel.

A. S. G.

Cloud Structure and Distributions over the Tropical Pacific Ocean. By Joanne S. Malkus and Herbert Riehl. (University of California Press, Berkeley 4, California 94720), 1965. Pp. 229. Price $ 7.50.

The book presents a study of cloud formations and distributions over the tropical Pacific Ocean in relation to the large-scale flow patterns. The study is based on motion pictures of clouds taken from an aircraft (altitude under 10,000 ft.) during three programmed complete flights in July-August 1957, taking the routes Honolulu-Kwajalein-Guam-Wake-Honolulu, covering about 15,000 miles. More than 8,000 ft. of film was exposed and photographs were taken by precision time-lapse technique at regular intervals. The analysis consists in correlating changes in cloud patterns in space and time with sky types as deduced from synoptic charts and rawinsonde network observations. This has enabled the authors to devise a "tropical whole sky code" consisting of seventeen numbers ascending in proportion to the degree of disturbance.

The book, which is largely descriptive, contains a number of cloud photographs including the whole sky code) and charts, and represents a first attempt to relate synoptic and cloud scale phenomena.

A. S. G.

Books Received

Physics of Thin Films (Vol. 2)—*Advances in Research and Development.* Edited by G. Hass and R. E. Thun. (Academic Press, New York), 1964. Pp. xii + 441. Price $ 15.00.

Solid State Physics (Vol. 16)—*Advances in Research and Applications.* Edited by F. Seitz and D. Turnbull. (Academic Press, New York), 1964. Pp. xvi + 446. Price $ 15.50.

Advances in Heterocyclic Chemistry (Vol. 3). By A. R. Katritzky. (Academic Press, New York), 1964. Pp. xiii + 421. Price $ 13.00.

Rapid Mixing and Sampling Techniques in Biochemistry. Edited by B. Chance, R. H. Eisenhardt, Q. H. Gibson and K. K. Lonberg Holm. (Academic Press, New York), 1965. Pp. xii + 400. Price $ 9.00.

Physical Processes in Radiation Biology. Edited by L. Augenstein, R. Mason and B. Rosenberg. (Academic Press, New York), 1964. Pp. xv + 377. Price $ 14.00.

Advances in Pharmacology (Vol. 3). By S. Garattini and P. A. Shore. (Academic Press, New York), 1965. Pp. viii + 341. Price 86 *sh.*

Newer Methods of Preparative Organic Chemistry (Vol. III). Edited by W. Foerst. Translated by H. Birnbaum. (Academic Press, New York), 1964. Pp. xiv + 544. Price 114 *sh.* 6 d.

Sir C. V. RAMAN

STUDIES of floral colour are of great assistance in giving both breadth and depth to our understanding of the visual sensations excited by polychromatic radiation. We may recall here a few striking examples which have already found mention in earlier chapters. The tree known as *Lagerstrœmia flos reginœ* has two varieties, one of which exhibits great clusters of rose-coloured flowers, and the other produces similar clusters of flowers having a purple hue, the flowers closely resembling each other in all other respects. Spectroscopic examination reveals that the rose-red flowers exhibit a nearly complete extinction of the green sector and thus belong to the colour category (1011), and that on the other hand, the purple flowers exhibit an extinction of the yellow sector and hence belong to the category (1101). Similar and very striking differences appear in the spectra of the light transmitted through a bract of a rose-red variety of bougainvillaea and through a bract of a purple variety.

In numerous cases, the efforts of horticulturists to introduce improved varieties of flowers which enjoy popular favour have resulted in producing forms which exhibit more attractive colours as also new colours. Spectroscopic examination enables us to determine the spectral character of the light diffused by the flower petals of the different varieties and hence to connect their differences in this respect with the differences in their perceived colours. In the preceding chapter dealing with the colours of roses, we have already had an illustration of the usefulness of such studies, especially when they are supplemented by an examination of the absorption spectra of the floral pigments extracted from the petals with the aid of acetone as a solvent. The investigation revealed that great differences in the perceived colours can arise as a consequence of the same floral pigment being present but in very different quantities in the petals of the roses. On the other hand, it also emerged that differences in colour appear in various cases which are ascribable to actual differences in the nature of the floral pigments. The results obtained with the roses suggested that the matter would be well worth pursuing in other cases of interest. We shall accordingly devote the chapter to setting out some further significant results which have been obtained in this field.

Pelargoniums.—These flowers (often referred to as geraniums) are highly esteemed by reason of their very attractive and continuous displays of colour. The blooms appear in clusters, and these are massed against a green background of leaves of peculiar shape. One particularly brilliant and colourful pelargonium exhibits a scarlet hue, but there are also other varieties a comparative study of the colours of which is evidently called for. The spectroscope reveals that the scarlet-hued flowers show by reflected light the spectral range extending from 570 mμ towards longer wavelengths, thus including both the red sector and a considerable part of the yellow sector. But the rest of the spectrum is missing, and in particular, the blue sector is not to be discerned. The brilliancy and high degree of saturation of the colour of the flowers are thereby made intelligible.

Examining other varieties of pelargonium, one meets with colours which are akin to scarlet but are less brilliant and less saturated in hue, e.g., orange, a pale orange and an orange-pink. The spectroscope reveals that they exhibit in addition to the part of the spectrum shown by the scarlet flowers, also part of the blue sector, while a gap appears between 480 mμ and 550 mμ which is evidently the region of the spectrum most strongly absorbed by the flower. The varieties which exhibit the blue sector more strongly and the gap in the spectrum less conspicuously are also those in which the colour of the flower is less brilliant and less saturated in hue. This indicates that the same floral pigment appears in these varieties as in the scarlet pelargoniums but in smaller quantities. This inference is confirmed by extracting the pigment from the scarlet flowers using acetone as a solvent. On diluting the extract by addition of acetone, we observe similar progressive changes in the colour and spectral character of the light transmitted by the solution.

There are also other pelargoniums which evidently form a class by themselves, *viz.*, those exhibiting a red colour, rose-pink and pale-pink hues. In all these cases, the red sector of the spectrum makes its appearance but the yellow and the green sectors are weakened, while on the other hand, the blue sector of the spectrum continues to be visible. The extinction of the yellow and the green sectors is complete in the case of the red flowers, but less so in the case of the rose-pink or pale-pink varieties. The blue sector also gains intensity in the latter cases. One may infer from these facts that the floral pigment present in pelargoniums is different in the scarlet and in the red varieties. In the latter, the pigment has a strong absorption in the yellow sector of the spectrum, while in the former such absorption is absent. This inference is confirmed by extracting the pigments respectively from the two varieties of flowers using acetone as a solvent and examining the spectrum of the light transmitted through a column of the extract under comparable conditions.

Hibiscus rosa sinensis.—Reference has been made in an earlier chapter to the large brilliantly coloured flowers of this plant. Seen either by reflected or by transmitted light, its petals exclude all parts of the spectrum of wavelength less than 600 mμ, thus accounting for their red colour. The characters of the floral pigment responsible for this spectral behaviour are better understood when it is extracted with the aid of acetone, leaving the petals colourless. The extract exhibits a deep red colour and an intense absorption covering all wavelengths less than 600 mμ. Using short absorption paths or else by diluting the extract with acetone, thereby allowing light of smaller wavelengths to come through, a strong absorption band between 580 mμ and 590 mμ reveals itself, as also another strong band between 530 mμ and 550 mμ. There is also a weak absorption band at about 500 mμ. The blue sector of the spectrum can be seen coming through though only weakly.

A rose-pink hibiscus (a hybrid of the *Rosa sinensis* type) has also been examined. As seen by reflected or by transmitted light, its petals showed a powerful absorption of the green sector, the rest of the spectrum remaining practically unaffected. The flower thus belongs to the colour category (1011). The acetone extract of the pigments of the flower examined

in a 2 cm. absorption tube showed a rose-pink colour. The blue sector of the spectrum could also be seen coming through very clearly. Absorption bands could also be seen in the green and the yellow sectors in the same positions as with the extracts from the red hibiscus. There is thus good reason for assuming that the pigments in the two cases are identical. Longer columns showed the change in colour from a rose-red to a deep red to be expected in the circumstances and also a more powerful absorption of all wavelengths less than 600 mμ.

Hibiscus syriacus.—The plant thus named is a native not of Syria but of India and is common in Indian gardens. It differs from *Hibiscus rosa sinensis* in the shape of its leaves and also in the manner of its flowering, the blooms appearing along the stem of the plant in the axils of leaves. The flower when it fades and closes up exhibits a blue exterior. But when the flower is open, the petals exhibit a purple hue. Spectroscopic examination reveals that this has its origin in the appearance of an absorption in the region of the yellow sector from 560 mμ to 590 mμ, the rest of the spectrum presenting its normal appearance. The flowers of *Hibiscus syriacus* (*Indica*) thus belong to the colour category (1101). The floral pigment can be extracted using acetone as solvent. The extract has a beautiful purple colour and transmits both the blue and the red sectors freely. With short columns, a strong absorption band appears in the yellow sector of the spectrum covering the spectral region from 560 mμ to 590 mμ. With longer columns, this region is completely extinguished, and a weak band in the green between 510 mμ and 530 mμ also makes its appearance. A very weak band is also seen in the red sector between 610 mμ and 630 mμ.

Bignonia magnifica.—This is a climbing plant which grows vigorously and is very showy, as it bears flowers in great profusion in large panicles. The colour of the fresh flowers is a rich purple. Examination of the spectrum of either the reflected or the transmitted light shows that the pigment present in the petals exercises an absorbing power in the spectral range between 500 mμ and 600 mμ, this being much more pronounced between 560 mμ and 590 mμ ; thereby effecting a nearly complete extinction of the yellow sector of the spectrum. On the other hand, the red sector is unaffected, while the blue is only slightly weakened. If

the flowers are kept immersed in water for 24 hours, the extraction of the pigment by use of acetone becomes readily possible. The acetone extract (if not too highly concentrated) exhibits a purple colour by transmitted light. Wavelengths greater than 600 mμ are freely transmitted and the blue sector also comes through, though sensibly weakened. Two dark bands are seen in the spectrum, one between 530 mμ and 550 mμ, and another between 580 mμ and 590 mμ, while the region from 550 mμ and 580 mμ has its intensity reduced to a small fraction of its normal value.

The Purple Orchids.—Of particular interest is the spectroscopic behaviour of orchids which exhibit a purple colour. The author has had an opportunity of examining several such orchids and found that they behave similarly. It is therefore sufficient here to consider the particular orchid known botanically as *Spathoglottis plicata.* This is a native of India and it is very hardy and can be grown on the ground or in pots like any other ordinary plant. The flowers are produced on spikes two or three feet long and the plant can easily be recognised by its palm-like leaves and the long spikes which hang out and bear flowers along their length and at their ends. The remarkable feature is that the spectrum of the light either reflected by or transmitted through the petals of the orchid exhibits a clearly defined set of absorption bands well separated from each other. The first band which is sharp and quite dark covers the spectral range from 575 mμ to 600 mμ and thus in effect extinguishes the yellow in the incident light. The second band is not quite so dark nor is it quite so well defined. It appears in the spectral range between 530 mμ and 555 mμ. A third and much weaker absorption is noticed in the spectral range between 490 mμ and 510 mμ. The rest of the spectrum including both the red and the blue sectors remains unaffected.

The floral pigment can easily be extracted from the petals of the purple orchids with the aid of acetone. The extract has a purple colour by transmitted light and exhibits the three absorption bands in the same positions. But there is a remarkable change in their relative intensities. The second band appearing in the green is now more conspicuous than the first band in the yellow. The third band is also quite conspicuous. Finally, the blue sector shows a distinct weakening. It will be noted

that the positions of the absorption bands both as seen directly with the petals and also in the acetone extracts are the same as those observed in the transmission of light by acetone extracts of red roses as set out in the preceding chapter. It is thus clear that we are here concerned with a definite chemical entity which plays a highly important role in the production of floral colours. What is specially remarkable is that when it appears in the petals of orchids, its spectroscopic behaviour manifests itself in such a clear and unmodified fashion.

Petrea volubilis.—This is the botanical name of a climbing plant which is a great favourite in Indian gardens by reason of the beautiful sprays of purplish-blue star-like flowers which it bears in profusion and which give the plant the popular name of the Purple Wreath. Racemes of flowers which are from fifteen to twenty centimetres in length crowd the plant, covering it up in a mass of colour. The most prominent feature of these sprays are the calices which remain after the true flowers have fallen off. The latter are quite small and their five petals have a much deeper colour. They can be seen resting on two or three of the end calices, one of the five having a white splash in the middle.

Spectroscopic examination shows that the colour of the sprays which is very striking as seen from a distance owes its origin to a weak absorption which manifests itself in the wavelength range between 570 mμ to 600 mμ and results in a sensible reduction of the intensity of the yellow sector of the spectrum, while the rest of the spectrum is not visibly affected. The tiny flowers of a deeper colour show the same features but in a more accentuated fashion, and give also an indication of an absorption band in the red at about 620 mμ.

The floral pigment which gives rise to the observed colour can be readily extracted from the flowers using acetone as a solvent and its absorption spectrum can be studied by observations on the light transmitted through a column of the extract of appropriate length. The extract can be prepared using either only the calices or only the true flowers. The results are of the same nature in both cases. The colour of the transmitted light is purple. Two bands are visible in the green sector of the spectrum, one between 520 mμ and 535 mμ, and the other between 560 mμ and 580 mμ, the latter

being much the stronger of the two. A third absorption band is also observed in the red sector between 615 mμ and 630 mμ.

Iris Germonica.—Iris form a very interesting class of plants which are remarkable for their curiously constructed flowers of attractive and gorgeous colours. *I. Germonica* has creeping rootstocks, sword-like leaves and bears flowers on erect stocks. The particular variety studied has flowers which exhibit petals of a blue-violet colour. Spectroscopic examination of the light diffused by the petals shows a large diminution of the intensity of the yellow sector of the spectrum and also a strong absorption in the red sector. The floral pigment can be readily extracted with acetone and the solution exhibits a beautiful purple colour. Spectroscopic examination of the light transmitted through a two-centimetre tube shows three absorption bands, one in the green between 510 mμ and 525 mμ, another in the yellow between 550 mμ and 580 mμ and a third in the orange red between 610 mμ and 620 mμ.

THE HOPE DIAMOND

THE legendary Hope Diamond is believed to have been cut from the 112-carat 'Tavernier Blue' which was discovered at the Kollur Mine, Golconda in India, in 1642 and became part of the French Royal Jewels. The 'Tavernier' disappeared in the famous robbery of 1792.... then, in 1830, the Hope appeared on the market, apparently recut to avoid recognition..... It was acquired by Mr. Harry Winston, the New York diamond merchant, in 1949 and presented by him to the Smithsonian Institution, Washington D.C., in 1958.

By courtesy of the Smithsonian Institution the diamond was recently made available to the Diamond Research Laboratory, Johannesburg, for a brief scientific study, the results of which have been reported by F. A. Raal in *Industrial Diamond Review* of June 1965.

The Hope Diamond weighs 44·5 carats and is mounted as a pendant on a necklace of white diamonds. As is commonly known, it has a very distinctive blue colour. It has a thickness of 12 mm., a large flat table and a collet measuring 2×2 mm. parallel to the table which makes it suitable for optical measurements. The light transmission of the diamond in the ultra-violet, visible and near infra-red regions of the spectrum, from 0·2 to 0·8 μ, was recorded on a Unicam S.P. 700 spectrophotometer. The spectrum is typical of those run-of-mine II b diamonds, and shows an increased light absorption towards the infra-red part of the spectrum.

The infra-red transmission spectrum in the range 2–15 μ was recorded on a Unicam S.P. 200 spectrophotometer. The spectrum shows a very strong absorption centred at 7·7 μ. This band has been observed in many II b diamonds, but never as pronounced as in the Hope.

A unique feature noticed with the Hope Diamond was the colour of its phosphorescence. It is known that II b diamonds phosphoresce with a light blue colour when irradiated by near ultra-violet light shorter than λ 3500 A. In the phosphorescence test, the Hope Diamond was irradiated with light from a high pressure mercury lamp with a quartz envelope. When the source was cut off, the diamond phosphoresced with a spectacular pinkish-red colour and glowed in the dark very much like a red-hot coal.

It is concluded that Hope is a strong II b diamond, and as such should be a semiconductor. What is intriguing is the fact that, to date, II b diamonds have been known to come from one source only—the Premier Mine near Pretoria. It now appears that the Kollur Mine might have been yet another origin.—(*Industrial Diamond Journal*, June 1965.)

ESTIMATION OF EVAPORATION FROM RELATED METEOROLOGICAL DATA

M. RAMA RAO AND T. S. GOVINDASWAMY

Meteorological Office, Poona-5

THE surface of the earth receives water from precipitation and loses the same to the atmosphere through the process of evaporation. The chief parameters which affect evaporation are temperature (both of the evaporating surface and the atmosphere), relative humidity of the atmosphere, wind velocity and the amount of radiation falling on the evaporating surface. Direct measurement of evaporation is done by the use of atmometers like Piche or water pans (sunken, surface or floating). Observations demonstrate that evaporation from atmometers or pans is not representative of natural evaporation. The emphasis has therefore been to compute evaporation, the need for which is being felt in many diverse fields of science such as Climatology, Agriculture, Hydrology, Biology and Micrometeorology. The importance is further demonstrated by the efforts that are being made by the World Meteorological Organisation to reduce evaporation values that are being recorded to a standard data.

The relation between "evaporating power" of air and the meteorological factors in general may be represented by:

$$E = (e_0 - e_a) \ f(u)$$

where E = evaporation in unit time.

e_0 = saturation vapour pressure at the water surface temperature.

e_a = vapour pressure of air.

$f(u)$ = function of horizontal wind at pan level.

Formula of the above type was used by Rohwer (1931) and Raman and Satakopan (1934) and by many other investigators. In this equation the most important factor affecting evaporation namely radiation is not taken into consideration. A number of formulæ have been presented later to arrive at reasonable estimates of evaporation. Among them are those of Penman (1948), Thornthwaite (1948), Blaney (1952) and Kohler (1957).

In the present study values of the weekly evaporation at Poona are calculated using Penman's formula. This has not been done so far. For a more detailed description of the evolution of the method reference may be made to "Evaporation in Nature" by H. L. Penman

in *Reports on the Progress in Physics*, Vol. XI, 1948. The necessary meteorological data were taken from the records of the Central Agricultural Meteorological Observatory, Poona, for 18 years. Penman's equation for daily evaporation from an extended sheet of open water is:

$$E = \frac{H + \frac{\gamma}{\triangle} E_0}{\left(1 + \frac{\gamma}{\triangle} \right)}$$

where H = net radiant energy available at the surface

$= R_c \ (1 - r) - R_B$

where R_c = measured incoming short wave radiation.

r = reflectivity.

R_B = net outgoing long wave radiation.

γ = psychrometric constant.

$\triangle$ = slope of the saturation vapour pressure *versus* temperature.

E_0 = aerodynamic evaporation term
$= f(U) (e_a - e_d)$.

e_a = saturation vapour pressure at mean temperature of air.

e_d = vapour pressure.

U = wind velocity.

This equation has been used for computing evaporation from observed meteorological parameters as follows: The evaporation E is in inches of water per day, temperatures in degrees absolute, wind in miles per day at 10 ft. which is the height taken for wind measurements at all Agri-meteorological and Crop-weather stations, temperature of air T_a is taken as the mean of the temperature at 0700 hr. and 1400 hr. Local Mean Time of the place (this is not very different from the mean of maximum and minimum temperature), vapour pressure in millibars, and energies in equivalent amounts of water evaporated in inches (with latent heat of vapourisation 590 cals./sq. cm. appropriate to our temperatures) and e_a is the saturation vapour pressure at temperature T_a and e_d the mean vapour pressure expressed in millibars. The formula for evaporation then becomes

$$E = [0.93 \, R_A \, (0.20 + .48 \, n/N) - 0.97 - T_a^4$$
$$(0.47 - .067 \sqrt{} \,)(0.20 + .80 \, n/N)$$
$$+ \gamma/\triangle\{.0105 \, (e_a - e_d)(0.50 + .01 \, U)\}]$$
$$(1 + \gamma/\triangle)^{-1}$$

R_A = net incoming short wave radiation at the outer limit of the atmosphere.

n = actual hours of sunshine per day.

N = maximum possible hours of sunshine per day.

The relation between R_c and R_A is given by the empirical equation

$$R_c = R_A \, (0.20 + .48 \, n/N).$$

For computational purposes the above equation was simplified by writing

$a = 0.93 \, R_A$ (function of latitude and time of year).

$b = 0.97 - T_a^4(0.47 - 0.067 - e_d)$ (function of air temperature and vapour pressure).

$c = .0105 \, \gamma/\triangle$ (function of air temperature).

$d = (1 + \gamma/\triangle)^{-1}$ (function of air temperature).

$f_1(n) = 0.20 + 0.48 \, n/N$ (function of sunshine and time of year).

$f_2(n) = 0.20 + 0.80 \, n/N$ (function of sunshine and time of year).

Equation for evaporation reduces to:

$$E = [a \, f_1(n) - b \, f_2(n) + c \, \{(e_a - e_d)(0.50 + .01 \, U)\} \, d.$$

Tables were drawn up for $f_1(n)$, $f_2(n)$, a, b, c and d, and computations made.

Table I gives the mean daily values of evaporation computed by the Penman's formula using meteorological data of 18 years by the present authors and those actually observed from open pan (screened) for a period of 3 years for the different months of the year and those computed earlier using Rohwer's formula by Raman and Satakopan (1934) and also by using Thornthwaite's formula by Subramanyam (1956). A comparison of the values is not called for but the table gives general features and essential soundness of Penman's equation. Values of evaporation at Poona for each week obtained by using the above formula are plotted in Fig. 1. It may be seen that highest values are obtained in May in association with higher wind speeds and sunny climate. The lower values in rainy season are associated with

humid conditions while the lowest values in winter are associated with low air temperatures and low wind speeds. It was also noticed during the analysis that during winter the values of long wave radiation from the earth are such that they not only retard evaporation but favour condensation. It may be seen from Fig. 1 that about 46% of the annual evaporation occurs during the summer months (March-June).

TABLE I

Month	Mean daily evaporation (mm.)		Mean daily potential evapotranspiration (mm.)	
	Observed class A pan (screened)	Computed from Rohwer's formula	Computed from Thornthwaite's formula	Computed from Penman's formula
January	3·8	7·0	2·0	2·3
February	5·6	7·5	2·8	2·9
March	8·4	10·4	4·6	4·1
April	10·4	15·0	5·5	5·0
May	8·6	11·8	5·9	5·6
June	7·9	7·5	5·3	4·4
July	3·3	4·4	4·2	3·2
August	3·6	3·7	3·7	2·9
September	3·8	3·8	3·7	3·1
October	4·1	4·7	3·8	3·2
November	3·8	6·2	2·6	2·7
December	4·1	5·6	1·9	2·2

Evaporation from land areas with vegetation is referred to as evapotranspiration as it is made up of evaporation from soil and water surfaces and transpiration from plants. Both free-water evaporation and potential evapotranspiration are measures of the maximum possible water loss from an area under a specified set of weather conditions and should be considered as equivalent. Evaporation from soil surface is comparable to that from a free-water surface provided the soil remains saturated with water. Actual evapotranspiration is considered to be smaller than potential evaporation. One of the reasons why it is smaller is that transpiration is negligible during night. Penman suggested that the value of potential evapotranspiration may be taken as 0·75 of open water evaporation. Using the above factor potential evapotranspiration at Poona for each week of the 52 weeks of the year was determined and plotted.

Figure 2 shows the average course of weekly rainfall and potential evapotranspiration at Poona. The evapotranspiration curve represents the water requirements of vegetation. The dip in the evapotranspiration curve in the 21st week seems to be a reflection of the higher rainfall value in that week. When rainfall exceeds the potential evapotranspiration the

excess is assumed to replenish soil moisture. The shaded area in Fig. 2 represents the weeks
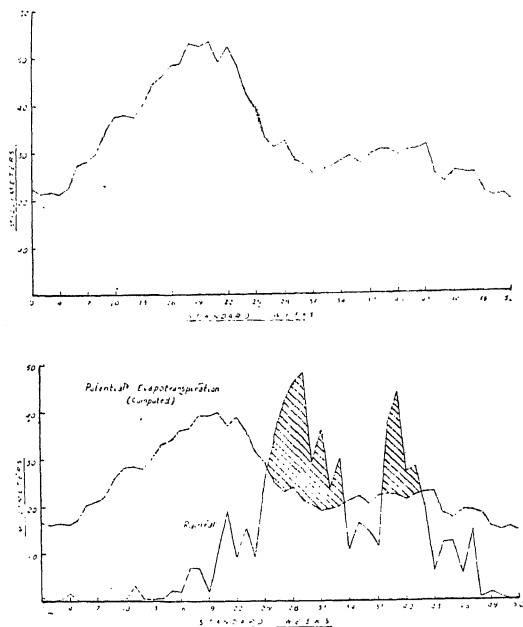
FIGS. 1–2

with water surplus. A knowledge of evapotranspiration is important in irrigation agriculture. In raising crops with the help of irrigation, the amount of water lost by evapotranspiration constitutes the minimum demand that has to be met with. Similar studies to determine potential evapotranspiration according to Penman using the valuable data collected at Crop-weather and Agrometeorological stations in India are in progress and it is proposed to publish potential evapotranspiration maps of India for each of the 52 weeks of the year which are so essential for finding out the water requirement of crops.

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ROTATION OF PLANET MERCURY FROM RADIO-ASTRONOMY OBSERVATIONS

MEASUREMENT of Doppler shifts in radio-echoes from Mercury seems to have yielded results contrary to what has been the general belief so long regarding the period of rotation of the planet. In the case of the two inner planets of the solar system, Mercury and Venus, it has always been thought that the planet's period of axial rotation is the same as its period of revolution around the Sun. For Mercury it is about 88 days each, and for Venus it is about 225 days each. Thus they are supposed to be presenting the same side to the Sun—as in the case of Moon around the Earth.

G. H. Pettingill and R. H. Dyce of Cornell University, reporting their measurements of radio-echoes from Mercury, studied with the 1000 ft. fixed radio-telescope in Puerto Rico, find that the rotation period of the planet is 59 ± 5 days. The direction of this rotation, like that of most planets, is counterclockwise with respect to a view from above its north pole. The exception, as other radio-astronomical studies have shown, is Venus which rotates slowly in a clockwise direction.—(*Scientific American*, June 1965).

ORIGIN OF THE LONAR CRATER*

V. VENKATESH

Geological Survey of India, 27, Chowringhee, Calcutta-13

THE Lonar Lake (19° 58′ 45″ : 76° 34′ 0″), a remarkably circular depression situated near Lonar village in the Buldana District of Maharashtra, has attracted the attention of scientists since first described in the 19th century. The shape and morphology of the depression are that of a crater and previous investigators (La Touche, 1912) have favoured an explosive eruption or a collapse as the causative phenomenon. Recent work (Beals, 1960) on circular features in several parts of the world ascribed either to cryptovolcanic phenomena or to meteorite impact, has provided the impetus to study the Lonar structure in more detail. Geophysical investigation and reconnaissance geological studies of the area were conducted by the Geological Survey of India in the first half of 1963.

The depression is unique in an otherwise gently rolling or flat topography, and no such feature is known in the surrounding country. The Lonar structure measures about 2,000 metres across at the surface and the large circular depression has a lake at its bottom. The depth from the rim to the lake level is about 140 metres and the sides of the depression are at 30° to the horizontal. A fairly continuous raised rim or bank (about 70 to 100 metres wide and 3 to 20 metres high) surrounds this depression. Previous observers (Nandy and Deo, 1961) have reported that the lake in its deeper central portion shows 5 metres of water followed by 30 metres of lake silt. The water spread of the lake is about 265 acres, and having no outlet, the waters are saline.

The Deccan trap lava flows (Cretaceous-Eocene) are the only rocks exposed for several miles around. These are amygdular or massive tholeiitic basalts that form several sub-horizontal flows. Around the Lonar crater, these flows show quaquaversal dips of about 10° suggesting a gentile domal structure. Large-scale faulting, intense shattering and brecciation and dykes are absent. The results of the seismic investigation of the structure are in general conformity with the drilling data (Nandy and Deo, 1961) and indicate the presence of a highly weathered or brecciated basalt below the lake silt.

Several similar structures have been attributed to cryptovolcanic phenomena (Bucher, 1963). The central 'high' and the annular depression are, however, absent at Lonar and intense fracturing, faulting, brecciation, collapse structures associated with such phenomena are also lacking. But the raised rim, domal dips and shape support the theory.

The chief obstacle in accepting a volcanic or cryptovolcanic theory is the age (La Fond and Dietz, 1964) of the depression. Such evidences as the drainage pattern, stream incision, breaching of the rim, embayment of outline, thickness of lake silt, and comparison with the Barringer Crater, show that the depression could not have originated earlier than Pliocene. In the absence of any volcanic or magmatic activity in the area after the Deccan trap episode in Eocene, it would appear unlikely that the structure could be related to magmatic activity.

The strikingly circular outline, depth-diameter ratio, raised rim, age and lone occurrence of the Lonar structure favour the meteorite-impact theory. Other crucial criteria like fracturing, brecciated material, impactite structure like shatter cones, 'mountain meal', glass or fusion crusts, ejected debris and meteorite fragments, could not be found. Trace element determinations of Ni, Co and Ti in rocks, soil, silt and vegetation in the crater showed no anomalous concentrations that could be ascribed to a nickel-iron meteorite.

The available data, therefore, are equivocal and the lack of intense fracturing and brecciation is an intriguing feature, whatever be the favoured theory of origin. The drilling data (Nandy and Deo, 1961) and the geophysical investigation provide evidence of a possible brecciated zone at the lake bottom. Investigation of this zone by diamond drilling may throw further light on the origin of this interesting structure.

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LETTERS TO THE EDITOR

INFLUENCE OF THE NUCLEAR SHELLS ON THE THERMAL NEUTRON CROSS-SECTIONS

FROM a survey of the available data on thermal neutron cross-sections it will be noticed that there is considerable variation in the cross-sections from element to element. Although apparently chaotic, the fluctuations in the cross-sections will be seen to exhibit certain shell effects as pointed out by Podgor.[1,2]

Broadly speaking, the thermal neutron capture cross-section is low at the magic numbers and takes high values intermediary through the filling up of the shell. In this respect its behaviour is similar to nuclear electric quadrupole resonance.

In the present investigation a number of elements (see Table I) have been studied and the experimentally obtained values of the cross-sections are given in Table I.

TABLE I

Element		Z	Cross-section in barns
Boron	..	5	765·2
Cobalt	..	27	44·9
Zinc	..	30	4·1
Zirconium	..	40	8·3
Rhodium	..	45	155·4
Palladium	..	46	11·53
Silver	..	47	70·3
Cadmium	..	48	2655·7
Indium	..	49	195·0
Tin	..	50	4·7
Samarium	..	62	16,779·00
Gadolinium	..	64	76,286·00
Dysprosium	..	66	2,413·00
Platinum	..	78	19·48
Gold	..	79	105·06

Of these the data on thermal neutron cross-sections for elements from rhodium ($Z = 45$) to tin ($Z = 50$), near the closing up of the proton shell $Z = 50$, is of interest. The total cross-section for these elements is taken to be that of the absorption inasmuch as the scattering in this region is very small. The cross-section gradually assumes high values with increasing number of protons and reaches a maximum at the proton number occurring just before the closing up of the shell. As the shell closes the cross-section falls off rapidly (Fig. 1). The other factor to be considered is

that these elements are just above the neutron shell $N = 50$. Considering the other elements that are studied B, Gd, Dy, and Au have high cross-section values. In the case of boron the high value of cross-section may be attributed to the proximity to the closing up of the proton shell $X = 8$. The samarium, gadolinium and dysprosium are rare-earth elements which are just after the closing up of the neutron shell $N = 82$ and the proton number is an intermediary between $Z = 50$ and 82. The high value of cross-section obtained for gadolinium suggests, that the same will be higher in the region where the new neutron shell is considerably filled than at the very beginning of the shell. Further, gold has a considerable thermal neutron cross-section since it lies in the vicinity of the closing up of the proton shell $Z = 82$.
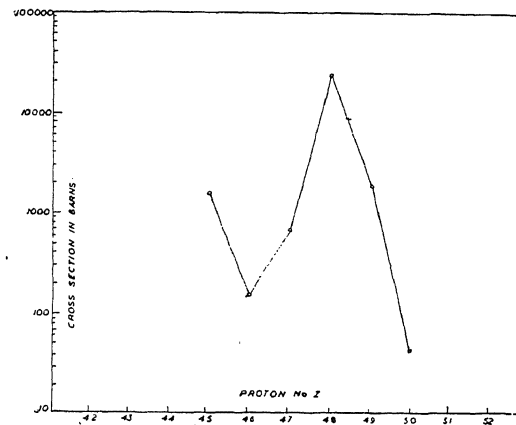
FIG. 1. Cross-section in barns *versus* the proton number Z near the Z=50 shell.

The $Z = N = 50$ or 82 are exceptionally stable aggregates of nucleons in the nuclei. These aggregates of nucleons are quite stable as to overcome the instability caused by either the increase in number of the same nucleons or due to the non-magic values of the nucleons of the other type. Herwitz and Bethe[3] pointed out that odd A nuclei tend to have higher thermal neutron absorption cross-section than even A nuclei, which can also be viewed from the binding energy of Seager's[4] semi-empirical atomic mass formula.

In the light of the above facts the following conclusions can be drawn about the influence of nuclear shells on the thermal neutron absorption cross-sections : (*i*) The cross-section is a maximum near the closing up of the proton shell. Besides the stable neutron number, a stable proton number has also to be passed before high values are reached. As soon as the proton shell is closed, the cross-section falls off sharply. (*ii*) The cross-section increases rapidly near the beginning of a neutron shell as can be seen from the data on rare-earth elements. Besides the shell effects, the high cross-sections may be attributed to the presence of energy levels in the compound nucleus corresponding to the neutron energy which causes the occurrence of large absorption.

The Laboratories for   B. B. VENKATAPATHI RAJU.
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DECAY OF Cr[51]

CHROMIUM-51 decays by electron capture to various energy states of Vanadium-51 as shown in Fig. 1.[1] The branching ratio for the decay
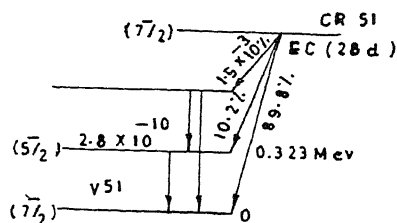

FIG. 1. Decay Scheme of Cr-51.

to 0·323 MeV state is of great importance in the standardization of the radioisotope by gamma-ray spectrometer. There are appreciable variations in the values of the branching ratio as reported by various authors.[2-7] The branching ratio has, therefore, been redetermined in our laboratory.

A NaI scintillation crystal was used for the detection of X-rays in view of its higher efficiency and shorter dead time compared to the proportional counter.[6,7] Very thin (0·015″) NaI crystals were used in order to reduce to

a considerable extent the contribution from 0·323 MeV gamma's to the X-ray channel. The total disintegration rate was measured by X-gamma coincidence method. A gamma-ray spectrometer was used to determine the disintegration rate to 0·323 MeV state of V.[51]

The authors have obtained a value of 10·20 ± 0·63 for the branching ratio which agrees well with the value reported by Bunker and Starner[5] and Bisi.[6]

Electronics Division,   K. C. DHINGRA.
Atomic Energy   U. C. GUPTA.
  Establishment,   N. P. S. SIDHU.
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GRAVIMETRIC DETERMINATION OF BARIUM AS SELENITE

EARLIER gravimetric methods for the determination of barium are as sulphate, iodate, nitrate and chromate. Low results are obtained under normal conditions of precipitation of $BaSeO_3.H_2O$ in aqueous medium; but in alcoholic medium quantitative results for the estimation of barium are obtained under controlled pH.

TABLE I
Determination of barium

Sl. No.	Weight of barium taken (mg.)	Weight of barium found by selenite method (mg.)	Difference (mg.)
1	546·1	545·7	0·4
2	109·2	108·9	0·3
3	137·0	136·7	0·3
4	204·7	203·9	0·8
5	274·0	272·7	1·3

To an aliquot of barium chloride solution taken in a beaker, an excess of alcoholic selenious acid (10%) was added followed by a drop of universal indicator, and pH of the solution adjusted to 7·5 with ammonia solution. Then about 20 ml. absolute alcohol was added and the precipitate digested on a water-bath for about

15 minutes, cooled and filtered through a previously weighed porous porcelain filter crucible and washed thrice with alcohol and finally with ether ; dried at 60° and weighed. From the data obtained the composition of the precipitate was found to be $BaSeO_3H_2O$. These results were further confirmed by analysing the precipitate by iodometric method and by the oxidation with alkaline ferricyanide by potentiometry. The values obtained are accurate and invariably within the limits of experimental error. Besides its simplicity and accuracy, the present method is convenient and rapid for the estimation of barium.

Sincere thanks of the authors are due to Professor G. B. Singh for providing the necessary facilities.

Division of Analytical   G. S. DESHMUKH.
   Chemistry,   A. L. J. RAO.*
Banaras Hindu University,
Varanasi, *January* 11, 1965.

* Present Address : Department of Chemistry, Panjabi University, Patiala.

CHEMICAL EXAMINATION OF
RANDIA ULIGINOSA DC

THE fruits of *Randia uliginosa* DC (N.O. Rubiaceæ) are used for the cure of dysentery,[1] and by the tribals of Madhya Pradesh as fish poison. The fruit pulp of *R. dumetorum* has been reported to contain a saponin of oleanolic acid.[2] The fruit of *R. uliginosa* also contains a saponin of oleanolic acid, mannitol (up to 6% in unripe fruits) and leucocyanidin. Toxicity to fish appears to be due to saponin.

Dried and powdered fruits were exhaustively extracted with cold ethanol. Residue after solvent removal and extraction with acetone gave an acetone-soluble product (A), and insoluble product (B). Product A on repeated crystallisation with ethyl acetate and petroleum ether mixture gave a brown solid, m.p. 150–85°, which appeared to be a leucoanthocyanidin. On heating with 5% ethanolic hydrochloric acid it gave a scarlet red product which was identified as cyanidin chloride by circular paper chromatography (R_f 0.85 and 0.53 in upper and lower phases of 4 : 1 : 5 butanol-acetic acid-water) λ_{max}. 540 mμ ; colour reactions and distribution in organic and aqueous solvents[3] agreed.

Product B after repeated crystallization with water and alcohol gave : (*a*) solid, m.p. 169°, acetate 120°, benzoate 149°, identified as mannitol by mixed m.p. with an authentic

sample of D-mannitol and its acetate and solid and (*b*) solid, m.p. 265–75° which on hydrolysis sulphuric acid gave genin, m.p. 290–98°. The acetylated product on chromatography over alumina gave acetyl derivative, m.p. 262–64°. It answered all tests of triterpenoids and on hydrolysis gave oleanolic acid, m.p. 304–06°, methyl ester, m.p. and mixed m.p. with an authentic sample of methyl oleanolate 197–98°.

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DISSOCIATION OF CARBON DIOXIDE ON A SUPPORTED IRON CATALYST *

INVESTIGATIONS on the chemisorption of carbon dioxide on a variety of evaporated metal films has shown the possibility of formation of carboxylate ions on transition metal surfaces and a slow dissociative adsorption, accompanied by liberation of carbon monoxide on non-transition metal surfaces.[1] The determination of adsorption isotherms of carbon dioxide on powders of transition metals, iron, cobalt and nickel have so far been utilised only in characterising the temperature range of physical adsorption and chemisorption.[2] The present investigation centres around the determination of the nature of chemisorption of CO_2 on the surface of the transition metal powder, iron.

The adsorbent was a reduced sample of iron-kieselguhr (5.15 gm.) prepared by the method of impregnation. The adsorption isotherms were determined at − 78, 0, 97, 150, 200 and 250° C. and up to a pressure of about 680 mm. Hg. employing an apparatus similar to that of Srinivasan.[3] At every temperature the adsorption was followed by desorption at the temperature of adsorption of the adsorbed gas by means of Topler pump, collection of the gas so desorbed and subsequent analysis in an Orsat gas analysis unit. When the adsorbed gas did not come out at the temperature of adsorption, the temperature was raised by 100° above the temperature of adsorption and the Topler pump used as before.

Data obtained have shown that all the CO_2 adsorbed at − 78° C. could be quantitatively

desorbed as CO_2 at the same temperature indicating that the adsorption at $-78°$ C. is purely physical in nature. At $0°$ C. and up to $200°$ C., Toplering even at $100°$ above the temperature of adsorption resulted only in the partial removal of the adsorbed gas leaving behind a small amount on the iron-kieselguhr. The desorbed gas, however, on analysis, was found to be pure CO_2. This leads to the conclusion that chemisorption of CO_2 on Fe-Kg must be setting in from $0°$ C. onwards.

It was observed that at $300°$ and above, the uptake of CO_2 was continuous and no equilibrium was reached even after 24 to 36 hours contact, suggesting that at these temperatures there was probably a chemical interaction between the gas and the adsorbent (Fe-Kg). This has been borne out by the presence of sufficient amounts of CO in the gas toplered out. Table I presents the results of the experiments in the temperature range of $300°$ to $450°$ C. from which it is seen that the desorbed gas contains carbon monoxide.

TABLE I

Temperature °C.	Volume of CO_2 adsorbed c.c. NTP	Time of contact (hours)	Volume of CO formed c.c. NTP
300	30·37	12	0·6
300	30·40	12	0·5
350	30·89	2	1·6
350	30·95	2	1·4
350	31·00	2	1·2
400	30·92	2	2·0
400	30·85	2	1·8
450	80·63	1	3·8
450	30·46	1	3·4

After completing a set of experiments on the Fe-Kg sample, it was soaked with hydrogen at $400°$ C. when water was detected in the capillary leading to the catalyst tube. This is obviously due to the reduction by H_2 of iron oxide formed by interaction of Fe with CO_2 at $300°$ C. and above. Analysis of the gas, after soaking in hydrogen, has shown, in addition to moisture, the presence of methane formed by the action of hydrogen on the iron carbide.

After the completion of a set of experiments, the catalyst was taken out and poured into alcohol. A fine powder of carbon was obtained.

The foregoing definitely leads to the conclusion that CO_2 reacts with the iron in iron-kieselguhr at temperatures of $300°$ and above to yield carbon monoxide as the only gaseous product, in addition to iron oxide, iron carbide and carbon.

Further experiments are in progress to identify the carbide and oxide formed by X-ray diffraction. A detailed account of the results obtained will be presented in due course.

The author expresses his gratitude to Prof. M. R. A. Rao, Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore, for his guidance and to Dr. V. Srinivasan and Prof. M. V. C. Sastri of Department of Chemistry, Indian Institute of Technology, Madras, for their helpful encouragement.

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A CONVENIENT SYNTHESIS OF WOGONIN

WOGONIN (I) was first synthesised by Shah, Mehta and Wheeler[1] by the partial demethylation of 5, 8-dimethoxy-7-hydroxyflavone (II) with aluminium chloride in nitrobenzene. It has been reported[2] from our laboratories that this reagent sometimes demethylates both 5- and 8-methoxyl groups and hence it may not be convenient. Further, there was a possibility of ring isomeric change during the flavone synthesis leading to the formation of 5, 6, 7-trihydroxy system instead of 5, 7, 8-trihydroxy system. For example, when anisic anhydride and sodium anisate were condensed with 2, 4-dihydroxy-3, 6-dimethoxyacetophenone, the reaction was accompanied by the ring isomeric change and 5, 7-dihydroxy-6, 4'-dimethoxyflavone was obtained.[3] A more convenient synthesis avoiding these difficulties was developed by Rao, Rao and Seshadri[4] using chrysin-7-benzyl ether (III). On nuclear oxidation with alkaline potassium persulphate it yielded 5, 8-dihydroxy-7-benzyloxflavone (IV) which by steps of partial methylation and debenzylation of the resulting methyl ether (V) gave wogonin (I). However, the persulphate oxidation of the 7-benzyl ether (III) gave poor yields,

Biogenetically the formation of wogonin (I) from 5, 7, 8-trihydroxyflavone (VI) may be visualised as due to the selective methylation of the 8-hydroxyl group. Since the 7-hydroxyl group in a flavone is more reactive for alkylation as compared with hydroxyl groups in the other positions, it should have been initially protected by a suitable group like the glycosidic group, thus leaving the hydroxyl groups in 5 and 8-positions free. Between these two hydroxyl groups, that in 5-position will be in chelation with the flavone carbonyl group and hence the 8-hydroxyl group would undergo methylation readily. Based on these considerations the present synthesis of wogonin (I) using benzyl group for the protection of the 7-hydroxyl group was undertaken. The trihydroxyflavone[5] (VI) was selectively benzylated using benzyl chloride, sodium hydrogen carbonate and sodium iodide as in the earlier cases of partial benzylation of esculetin[6] and baicalein.[7] Further, the use of acetone-alcohol mixture (9 : 1) as solvent has been found to be better in the present case than ethyl alcohol or acetone alone employed earlier, and the 7-benzyl ether (IV) was obtained in good yield. The later stages, *viz.*, methylation of the benzyl ether (IV) and subsequent debenzylation of the resulting benzyl methyl ether (V) were the same as in the earlier synthesis[4] except that the debenzylation was effected by hydrogenolysis instead of by acetic acid-hydrochloric acid mixture.
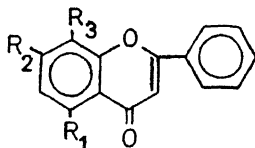
I, $R_1 = R_2 = -OH$; $R_3 = -OCH_3$
II, $R_1 = R_3 = -OCH_3$; $R_2 = -OH$
III, $R_1 = -OH$; $R_2 = OC_7H_7$; $R_3 = -H$
IV, $R_1 = R_3 = -OH$; $R_2 = -OC_7H_7$
V, $R_1 = -OH$; $R_2 = -OC_7H_7$; $R_3 = -OCH_3$
VI, $R_1 = R_2 = R_3 = -OH$.

During this work it was observed that the melting points of 7-benzyloxy-5, 8-dihydroxyflavone (IV) and its 8-methyl ether (V) were different from those recorded earlier.[4] In order to settle this discrepancy the earlier preparations were repeated and the revised melting points agree with those now found and the mixed melting points are undepressed.

7-Benzyloxy-5, 8-dihydroxyflavone (IV).—A solution of the trihydroxyflavone[5] (VI) (3 g.) in acetone-alcohol mixture (300 ml. ; 9 : 1) was treated with benzyl chloride (1·26 ml., 1 mole), sodium hydrogen carbonate (9 g.) and sodium iodide (1·5 g.). After refluxing the mixture for 24 hrs., it was filtered and the residue washed with acetone. Removal of the solvent from the combined filtrate yielded the benzyl ether (IV) (3·2 g.) as a pale yellow solid which crystallised from ethyl acetate-petroleum ether (40–60°) as yellow needles, m.p. 183–84° (revised) (Rao *et al.*[4] reported its m.p. as 220–21°) (Found : C, 73·5 ; H, 4·8 ; $C_{22}H_{16}O_5$ requires C, 73·3 ; H, 4·5%). It gave a green ferric reaction and was insoluble in aqueous sodium carbonate but dissolved in aqueous sodium hydroxide.

7-Benzyloxy-5-hydroxy-8-methoxyflavone (V).—The benzyl-methyl ether (V) was prepared according to the conditions of Rao *et al.*[4] and was obtained as colourless needles from ethanol m.p. 157–59° (revised) (Rao *et al.*[4] reported its m.p. as 208–10°) (Found : C, 73·9 ; H, 5·3 ; $C_{23}H_{18}O_5$ requires C, 73·8 ; H, 4·9%). It gave a green ferric reaction and was insoluble in aqueous sodium hydroxide.

5, 7-Dihydroxy-8-methoxyflavone (I).—A solution of the benzyl-methyl ether (V) (0·5 g.) in ethyl acetate (40 ml.) was stirred with palladised charcoal (0·5 g. ; 5%) in an atmosphere of hydrogen. After the absorption of hydrogen was over (about 2 hr.), the catalyst was filtered and the filtrate when concentrated and left at room temperature deposited 5, 7-dihydroxy-8-methoxyflavone (wogonin) (I) (0·3 g.) as yellow needles, m.p. 204–5° (lit.[1] m.p. 200–01°). (Found : C, 67·7 ; H, 4·6 ; $C_{16}H_{12}O_5$ requires C, 67·7 ; H, 4·3%). It gave a greenish-brown ferric reaction and dissolved in aqueous sodium carbonate.

Department of Chemistry,   D. K. Bhardwaj.
University of Delhi,   S. Neelakantan.
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CHLOROSULPHONATION OF ISATINS

SULPHONATION of isatin with fuming sulphuric acid has been reported[1] to form 5-sulphoisatin. During the course of our studies on diuretics, we had occasion to chlorosulphonate isatin, 4-chloro- and 6-chloroisatin with chlorosulphonic acid to their corresponding 5-chlorosulphonyl derivatives, which have been further reacted with ammonia and/or amines to obtain 5-sulphamyl or N-substituted 5-sulphamyl isatins. As a proof of the course of chlorosulphonation, 6-chloro-5-sulphamylisatin has been oxidised to the known[2] 2-amino-4-chloro-5-sulphamyl-benzoic acid.

5-Chlorosulphonylisatin.—To isatin (5·9 g.; 0·04 mole) cooled in ice, was added chlorosulphonic acid (46·6 g.; 0·4 mole); the reaction mixture was gradually heated to 70° and held at that temperature for two hours. The deep-brown reaction solution was then cooled and poured into ice (200 g.) to obtain 5-chlorosulphonylisatin (6 g.) as a yellow powder. It was crystallised from acetone-benzene; m.p. 150–52°. Found: N, 5·00; Cl, 24·70; Calc. for $C_8H_4ClNO_4S$: HCl : N, 4·97; Cl, 25·16%.

6-Chloro-5-chlorosulphonylisatin.—This was prepared starting from 6-chloroisatin following the procedure described in the above example; m.p. 177–78° (decomp.). Found: N, 4·20; Calc. for $C_8H_3Cl_2NO_4S$: HCl : N, 4·43%. The hydrochloride of 6-chloro-5-chlorosulphonyl-isatin on treatment with sodium acetate solution gave 6-chloro-5-chlorosulphonylisatin melting at 189–91°. Found: N, 5·01; Calc. for $C_8H_3Cl_2NO_4S$: N, 5·00%.

4-Chloro-5-chlorosulphonylisatin.—This was prepared starting from 4-chloroisatin following the procedure in the first example; m.p. 189–91°. Found: N, 4·14; Calc. for $C_8H_3Cl_2NO_4S$: HCl : N, 4·43%.

5-Sulphamylisatin.—5-Chlorosulphonylisatin (1 g.) was taken in liquor ammonia (5 ml.), filtered and acidified to congo red with 4 N hydrochloric acid to obtain the title product. It was crystallised from aqueous dimethyl-sulphoxide; m.p. > 320°. Found: N, 12·71; Calc. for $C_8H_6N_2O_4S$: N, 12·39%.

4-Chloro-5-sulphamylisatin.—It was prepared starting from 4-chloro-5-chlorosulphonylisatin and following the procedure described for 5-sulphamylisatin; m.p. > 320°. Found: N, 10·41; Calc. for $C_8H_5ClN_2O_4S$: N, 10·75%.

4-Chloro-5-benzylaminosulphonylisatin.—4-Chloro-5-chlorosulphonylisatin (1 g.) was heated with benzylamine (3 ml.) at 80° for 10 minutes.

The viscous deep-red reaction product was triturated with hydrochloric acid (20 ml.; 4 N). The resulting tacky solid was crystallised from aqueous ethanol; m.p. 172–74°. Found: N, 7·38; Calc. for $C_{15}H_{11}ClN_2O_4S$: H_2O : N, 7·60%.

5-Sulphamyl-6-chloroisatin.—It was prepared starting from 5-chlorosulphonyl-6-chloroisatin and following the procedure described for 5-sulphamylisatin; m.p. > 320°. Found: N, 10·69; Calc. for $C_8H_5ClN_2O_4S$: N, 10·75%.

5-Benzylaminosulphonyl-6-chloroisatin.—It was prepared starting from 5-chlorosulphonyl-6-chloroisatin and following the procedure described for 4-chloro-5-benzylaminosulphonyl-isatin; m.p. 195–97°. Found: N, 8·18; Calc. for $C_{15}H_{11}ClN_2O_4S$: N, 7·99%.

4-Chloro-5-sulphamyl-anthranilic acid.—5-Sulphamyl-6-chloroisatin (2·6 g.) was dissolved in sodium hydroxide solution (5%; 10 ml.) and stirred with hydrogen peroxide (30%; 3 ml.) at room temperature for 3 hours. It was then acidified to congo red with 10% sulphuric acid. The resulting solid was crystallised from aqueous ethanol; m.p. 264–66° (reported[2] m.p. 267–68°). Found: N, 10·87; Calc. for $C_7H_7ClN_2O_4S$: N, 11·18%.

Scientific and Technical Research Division, Sarabhai Chemicals, Baroda, *May* 7, 1965.

S. SOMASEKHARA.
(MISS) V. S. DIGHE.
G. K. SUTHAR.
S. L. MUKHERJEE.

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ON THE PRODUCT DISTRIBUTION PATTERN OF HYDROGENATIVE POLYMERIZATION OF ACETYLENE OVER PALLADIUM CATALYST

OF the various metals which catalyse the hydrogenative polymerization of acetylene, only palladium, particularly in the lower range of its concentration,[1] significantly promotes the formation of dimers, namely 1, 3-butadiene and butenes. However, only a few reports[1-3] are available in the literature on the formation of 1, 3-butadiene, *vis-a-vis* other products, by the hydrogenative polymerization of acetylene over palladium catalyst.

The hydropolymerization reaction of acetylene was studied by conducting experiments in a flow system under atmospheric pressure using a Pd-ZnO-Cr_2O_3—kieselguhr (0·02 : 5·0 : 4·6 : 100) catalyst. The incorporation of ZnO and Cr_2O_3 was made as it was found to suppress

ethylene formation and augment acetylene conversion to 1, 3-butadiene. The variables studied included reaction temperature (220° to 320° C.), volumetric space velocity (820 to 13120 hr.$^{-1}$ at N.T.P.) and feed-gas composition. The reaction products higher than C_4 were condensed out in cooling traps and collectively termed as 'oil'.

A plot of per cent conversion of acetylene into various products against the overall acetylene conversion, and its subsequent extrapolation to 'zero' conversion of acetylene, has established the fact that the reaction over palladium catalyst comprises three primary reactions, namely (*i*) hydrogenation of acetylene to ethylene, (*ii*) dimerization and hydrogenation of acetylene to 1, 3-butadiene and (*iii*) hydrogenative polymerization of acetylene to oily hydrocarbons. In order to evaluate the initial rates of these three reactions, the corresponding once-through conversions have been plotted against 'time-factors', defined as gm. of catalyst ×Hr./moles of feed, and slopes of the curves extrapolated to 'zero' time-factor determined. It has been found that the initial rate data are in best accord with the initial rate equations given below, which are derived[4] on the assumption that all the three primary reactions (stated above) take place between adjacently adsorbed acetylene molecules and hydrogen atoms, and that the rate-controlling step for both the ethylene and butadiene-forming reactions is the adsorption of hydrogen while that for the oil-forming reaction is the adsorption of acetylene.

The initial rate equations are:

$$r_{0(e)} = n_{H_2} / (a + b \times n_A)^2$$
$$r_{0(b)} = n_{H_2} / (a' + b' \times n)^2$$
$$r_{0(o)} = n_A / (a'' + b'' \times \sqrt{n_{H_2}})$$

where $r_{0(e)}$, $r_{0(b)}$ and $r_{0(o)}$ are the initial rates of formation of ethylene, 1, 3-butadiene and oil, expressed in grammoles of acetylene converted to the respective products per gram of catalyst per hour; n_A and n_{H_2} are mole fractions of acetylene and hydrogen in feed-gas. The constants: a, b, a', b', a'' and b'' have been related to the reaction temperature T (°K) by the following equations of the Arrhenius form:

$$a = 4 \cdot 236 \times 10^5 \times e^{-7 \cdot 141 \times 10^3/\text{T}}$$
$$b = 2 \cdot 831 \times 10^{-4} \times e^{5 \cdot 297 \times 10^3/\text{T}}$$
$$a' = 1 \cdot 365 \times 10^{-3} \times e^{3 \cdot 914 \times 10^3/\text{T}}$$
$$b' = 9 \cdot 307 \times 10^{-2} \times e^{2 \cdot 337 \times 10^3/\text{T}}$$
$$a'' = 1 \cdot 811 \times 10^2 \times e^{-1 \cdot 842 \times 10^3/\text{T}}$$
$$b'' = 1 \cdot 479 \times 10^{-13} \times e^{1 \cdot 635 \times 10^4/\text{T}}$$

The product distribution pattern can be derived from the initial rates of the three primary reactions. Thus, for ethylene

% of C_2H_2 converted to C_2H_4

$$= \frac{r_{0(e)} \times 100}{r_{0(e)} + r_{0(b)} + r_{0(o)}}$$

Product distribution in respect of ethylene, 1, 3-butadiene and oil, thus computed, has been corroborated by experimental results.

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Department of Chemical   MANAS CHANDA.
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PRELIMINARY STUDIES ON FOLIAR SCLEREIDS IN *FAGRAEA*

THE presence of foliar sclereids in the genus *Fagræa* (Loganiaceæ) is mentioned earlier[1,3] but very little is known either about their comparative morphology or positional relationship within the mesophyll tissues. A comparative study of foliar sclereids was made in three locally available species of this genus and some of the important points of this research are presented here.

Fagræa fragrans Roxb. is an evergreen characteristic tall tree, sometimes reaching upto more than 100 ft., and distributed both on the coast as well as inlands of Malaysia. The simple, small, emarginate leaves are thin, arranged alternately on the slender twigs; and on an average measure $3\frac{1}{2}'' \times 1\frac{1}{2}''$. Its growth habit, periodicity of flowering and fruiting, have been well described.[4] *F. ridleyi* King and Gamble is a rare spreading shrub, present mostly inside the primary forests, with obovate coriaceous leaves which on an average measure $9'' \times 5''$. *F. auriculata* Jack. is also a shrub of primary forests with obovate, prominently veined leaves that measure on an average $11'' \times 3''$. The procedures previously outlined by Foster[5] and Arnott[6] for clearing, sectioning

and staining the leaves were followed, to obtain the necessary microscopic preparations.

In all the three species, the outer cell-walls of the epidermis are thickened with prominent cuticle. Beneath the upper epidermis a distinct hypodermis is present; 1-layered in *F. fragrans*, 2-3-layered in the other two species (Figs. 1-3). The cells of the hypodermal layers are compactly arranged, with no air-spaces between them. Further, the palisade and spongy layers are fairly distinct, the cells of the latter being more loosely arranged than the former. The lower epidermis shows a wavy outline, the outer cell walls of which are covered with cuticle, except for the intervening stomata (Figs. 1-3).
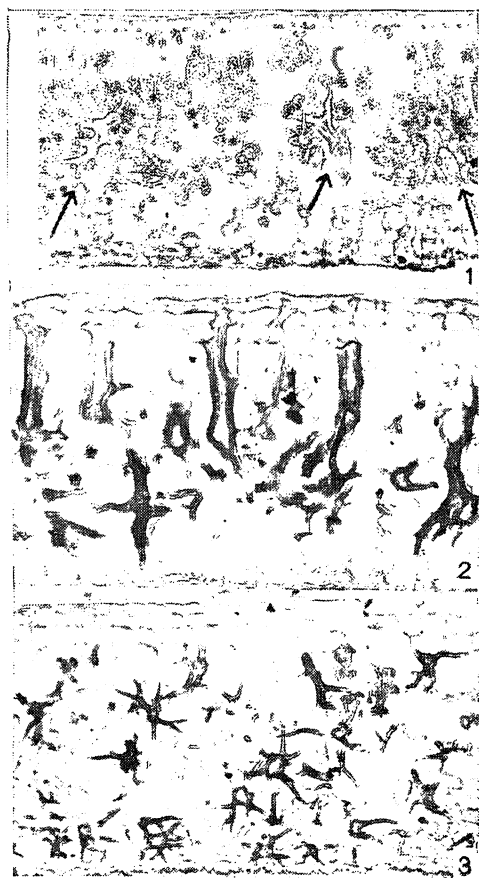
FIGS. 1-3. Fig. 1. T.s. leaf showing the distribution of sclereids in *F. fragrans*, × 100. The arrows indicate the position of the sclereids. Fig. 2. T.s. leaf of *F. ridleyi*, × 80. Fig. 3. T.s. leaf of *F. auriculata*, × 167.

Observations of the cleared laminæ of all the three species have shown that the sclereids are predominantly diffuse in their distribution,

though few of them occasionally are present near the tips of the veinlets. In such cleared preparations, very few sclereids are present per given areole in *F. fragrans*, more in *F. ridleyi* and most in *F. auriculata*, increasing in number and density in that order. This variation in the density of sclereids in the mesophyll can also be clearly seen in the transections of leaves. Further, although the sclereids in all the three species are of stellately branched, ramified type, they show different cell characteristics with regard to cell-wall structure, size and shape. Even the distribution of these, in relation to the other leaf tissues, is different in each species. With regard to the distribution, the sclereids in *F. fragrans* are mostly restricted to the middle region of the mesophyll, while the branches of these occasionally extend towards the air-spaces of the spongy mesophyll (Fig. 1). Under higher magnification the sclereid cell shows a central narrow lumen, and a thick laminated cell-wall with pit canals. In *F. ridleyi* the sclereids present in association with the hypodermal layers extend up to adaxial epidermis, and sometimes even to the cuticle. Besides, these sclereids are much bigger with stout 'axes', from which few short branches or spicules radiate. The central lumen is prominent and simple pits are present on cell-walls. On the other hand, the ones present in the spongy mesophyll are smaller with more elongated branches, and a small lumen (Fig. 2). In *F. auriculata* the sclereids that are present immediately below the hypodermis are slightly bigger with fewer branches than those in the middle and towards the lower epidermis (Fig. 3). This variation in size as well as the branching of the sclereids are more obvious in macerated preparations.

Among the three species, if a comparison is made with regard to the sclereid size, the smallest sclereids are present in *F. fragrans*; biggest ones in *F. ridleyi*, and the ones in *F. auriculata* are intermediate. The laminations of the thick cell-wall seen in *F. fragrans* are absent in the other two species and the homogeneous cell-wall is much thicker in *F. ridleyi* than in *F. auriculata*. More number of pits are present in the cell-wall of the latter than the former. The ramifications of the hypodermal sclereids of *F. auriculata* do not extend to the epidermis as those of *F. ridleyi*. It may be suggested that the differences seen in the distribution of the sclereids within the mesophyll tissues, their number per areole, as well as the above-mentioned cell characters of

the sclereids serve as useful anatomical characters of leaves, which in combination with the leaf morphology will be helpful in the identification of these species. As far as their relationship with the veins are concerned, in all the three species, they are either terminal or diffuse in their distribution, as previously observed in another species, *F. obovata*.[3] In all, there are 20 species recorded in this genus[7,8] which are chiefly Indo-Malayan in distribution ; and if such studies are extended in case of others, the sclereid and leaf characters thus enumerated may be helpful in the construction of a usable key for species identification. Such a key, when completed may be of additional diagnostic value along with the floral characters, especially to identify the big-leaved epiphytic species of the deep tropical forests, the flowering habit of which is so poorly recorded and the flowers so rarely observed.[7,4] In systematic anatomy as well as the identification of taxa, the importance of different anatomical characters in general and those of sclereids in particular are already well mentioned by several authors.[1,2,9-12]

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IN VITRO POLLINATION IN ANTIRRHINUM MAJUS L.

In recent years the technique of tissue and organ culture has also been employed to grow ovaries on synthetic media. Several investigators have successfully cultured the pollinated ovaries of *Althaea rosea, Iberis amara, Linaria maroccana, Ranunculus sceleratus* and *Tropaeolum majus* (see Maheshwari and Rangaswamy, 1963). However, Dulieu (1963) cultured the unpollinated pistils of *Nicotiana tabacum* on a nutrient medium and pollinated them on the following day. Pollination and fertilization occurred normally and seeds were obtained. This paper describes the results obtained in *Antirrhinum majus*, a member of Scrophulariaceæ.

Flower-buds of *Antirrhinum majus* were harvested prior to anthesis. The petals as well as stamens were removed and the pistils with the calyx intact were surface-sterilized by dipping them in 70% alcohol and later in strong chlorine water. After washing them with sterile water the pistils were cultured on Nitsch's nutrient medium with 4% sucrose and 25% coconut milk. At the time of culturing the ovaries measured 2–2·5 mm. in diameter (Fig. 1 A). Pollen from the anthers of the same flower was now deposited on the stigma. Some cultures were left unpollinated to serve as controls.

The pollen grains started germinating on the stigma within four hours after pollination. Dissections of styles from 24-hour-old cultures revealed some tubes traversing different lengths of the style.

The unpollinated pistils showed very little growth and turned brown after a week. On the other hand, the pollinated pistils started enlarging in four or five days after culturing. Figures 1 B, 1 C show 10- and 20-day-old cultures of the pistils. The ovules from the developing ovaries were examined periodically. In 8-day-old cultures the ovules showed a globular proembryo. Ovules from 12-day-old ovaries had heart-shaped embryos and 18-day-old cultures possessed embryos in which the cotyledons had just been initiated. In 22-day-old ovaries the seeds contained fully formed embryos. The development of the endosperm also took place concurrently. The ovaries at maturity measured 8-9 mm. in diameter and the colour of the ovary wall changed from dark green to light green. The seeds developed a characteristic black colour (Fig. 1 D) and germinated on the basal medium. However, the test-tube fruits contained only about 180 seeds in contrast to 400-500 seeds developed under field conditions.

During the past decade several techniques have been devised to overcome the barriers to crossability. Kanta (1960) and Maheshwari and Kanta (1961, 1962) have demonstrated that fertilization can be brought about by injecting a pollen suspension into the ovary. However, the technique of intraovarian pollination is specially useful in such instances where the zone of incompatibility lies in the stigma and

style and where the ovary has enough space to accommodate the pollen suspension. Recently of *in vitro* pollination described here appears to be specially promising.
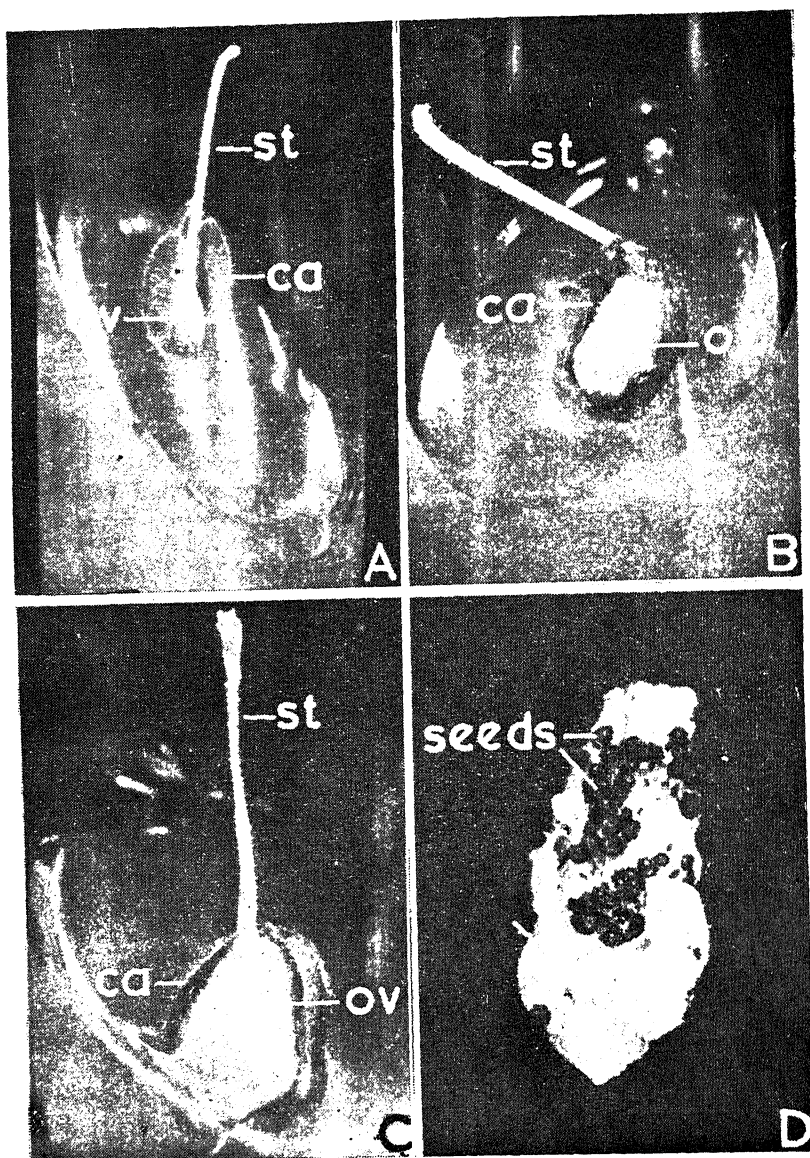
FIG. 1 A–D. *In vitro* pollination of the pistil of *Antirrhinum majus* L. A. Pistil at time of culture, × 1·9.   B, C. Ten- and twenty-day-old cultures of pistils showing the enlarging ovaries, × 2·1. D. Ovary wall removed from thirty-day-old culture to show mature seeds, × 2·1. (*ca*, calyx; *ov*, ovary; *st*, style.)

Kanta *et al.* (1962) have also shown that ovules and pollen can be cultured simultaneously on an artificial medium, and fertilization brought about in the absence of any gynoecial tissue. However, this technique has been successful only in a few plants. In this context the technique

Department of Botany,   S. V. Usha.
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ESTIMATION OF NITRATE AND NITRITE NITROGEN IN SUGARCANE JUICE

COLORIMETRIC methods for estimating nitrate nitrogen using phenoldisulphonic acid[1] or brucine[2] require the use of concentrated or fuming sulphuric acid and cannot be utilized for estimation of nitrates in cane juice since the sugar present in the juice gets charred. Reduction of nitrates to ammoniacal nitrogen under alkaline conditions using Devarda's alloy followed by its distillation, collection and estimation of ammoniacal nitrogen is not a correct procedure since some of the amino and other soluble organic nitrogen is also likely to get hydrolysed by alkali during distillation. Authors' experience in plant tissue testing suggested the possibilities of using Brays[3] powder mixture[4] for estimating nitrates in juice. Our first attempts were not successful since cane juice contains a lot of colouring matter. Nitrates could, however, be very easily estimated after clarifying the juice with lead sub-acetate.

To 50 ml. clarified juice or standard solution in an Erlenmeyer flask was added 1 g. Bray's powder, the contents were shaken and centrifuged after 15 minutes. Intensity of the pink-red colour developed was read with Fisher Electorphotometer using green filter (525 mμ). The readings should preferably be taken before 30 minutes are over. A standard curve was prepared with solutions of known nitrate content (0·1–2 ppm NO_3-N). The amounts thus estimated also included nitrite nitrogen, since in this method nitrates are estimated after their reduction to nitrite.

A powder mixture containing 4 g. sulfanilic acid, 2 g. alphanaphthylamine ` and 100 g. $BaSO_4$ was utilized for estimating nitrites, separately. The procedure adopted was same as for nitrates but with the addition of 5 drops of glacial acetic acid and readings were taken after 5 minutes but before 15 minutes were over. A standard curve was prepared with solutions of known nitrite content (0·01 to 0·2 ppm NO_2-N). Subtraction of nitrite-N from the nitrite + nitrate-N permits the estimation of nitrate nitrogen. Results for 3 cane juice samples and two gur samples are given in Table I.

TABLE I

Nitrate and nitrite nitrogen content of sugarcane juice and gur samples

		NO_3+NO_2-N	NO_2-N	NO_3-N
Juice sample :		ppm	ppm	ppm
1	..	1·100	0·020	1·080
2	..	1·880	0·028	1·852
3	..	0·400	0·040	0·360
Gur sample : *				
4 Pulverised gur (superior quality)		1·400	0·150	1·250
5 Ordinary gur	..	3·200	0·200	3·000

* A 5% solution was used.

The method reported here can also be used for accurate estimation of nitrate and nitrite nitrogen in fruit juices, gur and raw sugars.

Division of Agronomy,   B. A. Lakhdive.
I.A.R.I., New Delhi-12,   Rajendra Prasad.
March 8, 1965.

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4. Four grams sulfanilic acid, 2 g. alpha-naphthylamine, 10 gm. $MnSO_4$ H_2O 2 g. finely powdered Zn, 100 g. $BaSO_4$ and 75 g. citric acid are ground separately and then mixed thoroughly. The powder should be stored in a bottle painted black.

VERTICILLIUM WILT OF PYRETHRUM IN MYSORE

VERTICILLIUM wilt is one of the most common and destructive diseases of numerous host plants including many economic crops. It attacks nearly 300 cultivated plants of diverse families and it may persist as a saprophyte in the soil for 15 years or more. It occurs in a very wide range of habitats particularly in cooler climates especially in Western countries.

In India first record of verticillium wilt was made by Patel *et al.* on egg plant in 1949, which

was first noticed in 1938 and was identified as *V. dhaliæ* Kleb. Since then it has been reported from several other localities in the Bombay State. Numerous workers have studied the morphology, cultural characters, physiology, pathogenicity and host range of the fungus. Recently Fordyce *et al.* in 1964 studying anastomosis and parasexual recombination between cultures representative of *V. albo-atrum* Reinke and Berth and *V. dhaliæ* lend evidence to the hypothesis that these are only strains of a single species and should be combined as *V. albo-atrum.*

Pyrethrum (*Pyrethrum cinerariifolium* Trev.) is a medicinal plant the flower-heads of which are used as an insecticide in the form of powder or as a prepared extract. Pyrethrum wilt caused by *Verticillium albo-atrum* was first reported in Washington, U.S.A., by Jones and Huber in 1932.

The verticillium wilt on pyrethrum was observed in Bangalore on some of the plants grown for experimental purposes. A pure culture of the fungus was obtained on potato dextrose agar media and it sporulated in 10 days.

The present record of verticillium is of interest since no verticillium species is known on pyrethrum in India. The diseased plants show stunted growth, and the lower leaves gradually turn yellow, wither and drop off. Some plants may dry prematurely. Newly infected plants show light brown discolouration in the wood of the roots and bases of the stems. Plants that have been diseased for some time show a dark brown discolouration of the wood of the roots of the plant.

The mycelium is spreading and the conidiophores are erect, single, paler at the apex, verticilliately branched with occasional branches. The terminal branchlets are thickened at the base and narrowed at the apex. Conidiophores are 66–118 μ and conidia are elongate, egg-shaped, hyaline 6–10·5 × 0·98–3·3 μ. Microsclerotia were formed within 30–40 days in the culture. The mycelium turned to black colour before the microsclerotia were formed. The average diameter of the microsclerotia measured 9·24 to 10·04 μ. The fungus was identified as *V. albo-atrum.*

Care should be exercised in preventing the spread of the disease, if large-scale cultivation of pyrethrum is undertaken.

Division of Plant   N. Shivanandappa.
Pathology,   H. C. Govindu.
Agricultural Res. Inst.,
Hebbal, Bangalore-24, *April* 29, 1965,

1. Fordyce Claude (Jr.) and Ralph, J. Green (Jr.) *Phytopath.,* 1964, 54, 795.
2. Jones, L. K. and Huber, G. A., *Ibid.,* 1932, 22, 14.
3. Patel, M. K., Qureshi, I. M. and Bhide, V. P., *Indian Phytopath.,* 1949, 2, 245.

FLORAL MORPHOLOGY AND CHROMOSOMES IN *BURSERA DELPECHIANA* POISS.

Bursera delpechiana Poiss. is the well-known Mexican Lavender native to tropical and sub-tropical America. In Mexico, the species grows extensively and is the basis of a flourishing aromatic oil industry. The oil is distilled chiefly from the wood and to a small extent from the berries. Mexican Linaloe oil is a highly valued perfumer's raw material which is incorporated into perfumes, cosmetics and soaps.

Although it is more than fifty years since this exotic was introduced into India, its large-scale cultivation and extension are comparatively recent. At the present time Bursera is grown on over a thousand acres and is being steadily extended. It is known as the "Indian Linaloe" or "Indian Lavender". In a comprehensive article Ramaswamy and Range Gowda[1] have described the story of the introduction of the species, cultural practices adopted in its cultivation and propagation, and distillation of oil. In India the oil is distilled from the pericarp of the berries after the mature fruit drops to the ground. The Indian Linaloe oil differs from its Mexican counterpart in having a somewhat higher specific gravity, lower refractive index and substantially higher ester content. The Indian Lavender oil is chiefly used by the soap and cosmetics industry.
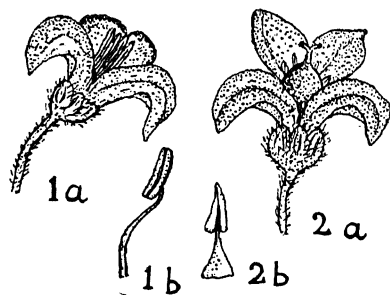
FIGS. 1-2. Fig. 1 *a.* A male flower. Fig. 1 *b.* A single stamen from the male flower. Fig. 2 *a.* A hermaphrodite flower. Fig. 2 *b.* A single staminode.

In spite of the scientific and economic importance of this exotic now being acclimatised

in this country, not much is known to date of its botany. We have therefore taken up a comprehensive study of the botany of *Bursera delpechiana* and this note summarises our first findings.
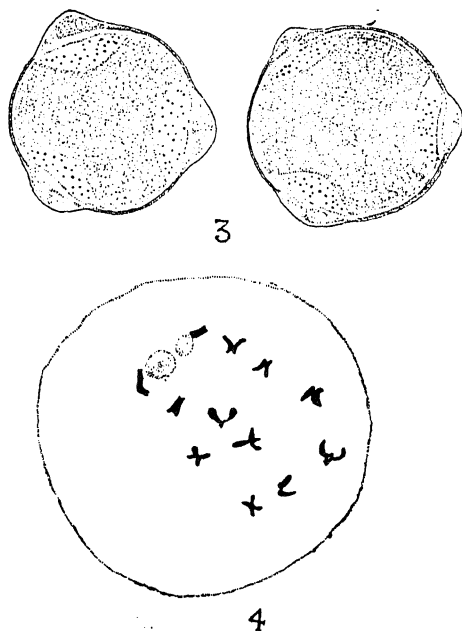
FIGS. 3-4. Fig. 3. Pollen grains from the staminate flower in polar view, × 727. Fig. 4. P.M.C. showing 12 bivalents at diakinesis stage, × 727.

B. delpechiana, a tall shrub, bears small flowers on compound racemes. The flowers are either staminate or hermaphrodite and borne on different individuals. They are regular and tetramerous. In the staminate flowers (Fig. 1 *a*), anthers are dorsifixed (Fig. 1 *b*), stamens arc eight in number, twice as many as petals and obdiplostemonous with free filaments inserted below the disc. The pollen grains (Fig. 3) are radiosymmetric, 3-zonipororate and the outline in polar view is triangular with slightly convex sides. Ectoporium circular, pores aspidote and apsis passes through the mesaspidar part of the exine. Exine is thick except at the pore regions with smooth outer surface. Ectine and endine are nearly the same in thickness.

In hermaphrodite flowers (Fig. 2 *a*), stamens are 8 in number but reduced to staminodes and no sporogenous tissue is formed. The filaments of the staminodes are flattened and triangular (Fig. 2 *b*). The pistil is normal with a bifid

stigma. The ovary is bicarpellary, syncarpous and tetralocular, each locule containing a single ovule. There is a prominent disc. Pollination is entomophilous.

Pairing of chromosomes is normal and 12 bivalents appear in diakinesis (Fig. 4). The bivalents do not show more than one chiasma. Segregation is normal leading to the formation of fertile pollen grains.

The authors wish to thank Dr. M. N. Ramaswamy for his interest in the work and encouragement.

Central Indian Medicinal   G. N. SRIVASTAVA.
  Plants Organisation,   K. V. SRINATH.
Bangalore-11, *May* 19, 1965.

1. Range Gowda, D. and Ramaswamy, M. N., "The Indian Linaloe, *Bursera delpechiana,*" *Perfumery and Essential Oil Record*, 1965, **56,** 85.

DOLICHOS LABLAB, A NEW PYCNIDIAL HOST OF *MACROPHOMINA PHASEOLI* (MAUBL.) ASHBY

Macrophomina phaseoli (Maubl.) Ashby is known to produce charcoal rot of as many as 301 species of plants in different parts of the world. The fungus usually produces sclerotia on the roots but is also known to produce pycnidia on the stems of certain plants.

Recently the pycnidial stage of the fungus was observed on stems of *Dolichos lablab* growing in a kitchen garden of Karachi, Pakistan. It produced a blight disease on the stems. The fungus does not appear to have been reported on *Dolichos lablab* so far. Pycnidia were black, ostiolate, more or less erumpent, globose to subglobose and measured $51-176\,\mu \times 39-157\,\mu$. Pycnospores were hyaline, one-celled, more or less elliptical and measured $15 \cdot 6-27 \cdot 4\,\mu \times 5 \cdot 9-7 \cdot 8\,\mu$. On agar media single pycnospores produced smooth, black sclerotia of the fungus which measured $47-176\,\mu \times 39-157\,\mu$.

The specimen has been deposited in the National Mycological Herbarium, Ministry of Agriculture, Karachi, accession No. 4131.

Dept. of Botany,   ABDUL GHAFFAR.
University of Karachi,
          and
National Mycological   ABDUL KAFI.
  Herbarium,
Ministry of Agriculture,
Karachi, *May* 24, 1965.

REVIEWS AND NOTICES OF BOOKS

Physical Acoustics—Principles and Methods, Volume II—Part A: *Properties of Gases, Liquids, and Solutions.* Edited by Warren P. Mason. (Academic Press, New York and London), 1965. Pp. xv + 476. Price $ 17.00.

Parts A and B of the first volume of this multivolume work were reviewed recently in *Current Science,* March 5, 1965, page 161.

In this volume, methods for detecting and generating sound waves are evaluated, followed by discussions of their use for the determination of the properties and interactions between atoms and molecules in gases, liquids, and solutions. The first three chapters of this volume consider the properties of gases from rarefied to condensed phases. Interactions or relaxations are determined by acoustic measurements and related to molecular properties by irreversible thermodynamics.

The next two chapters are concerned with the two types of relaxations found in liquids— thermal relaxation and molecular structural rearrangement. The final chapter is devoted to acoustic measurement of the material arrangement of electrolytic solutions and the propagation of ultrasonic waves. **C. V. R.**

Physical Processes in Radiation Biology— *Proceedings of an International Symposium, held at the Kellog Center, Michigan State University, May 5-8, 1963.* Edited by Leroy Augenstein, Ronald Mason and Barnett Rosenberg. (Academic Press, New York and London), 1964. Pp. xv + 377. Price $ 14.00.

In this volume, thirty-four eminent biologists, biophysicists, physicists, and physical chemists take up the core problem of radiation biology—how high energy packets (protons or particles) are absorbed, distributed, and utilized in biological systems. The book emphasizes the following topics: the nature of exciton processes; the mechanisms of charge transport in biological materials; the interactions of fast and slow electrons with model systems; the importance of liquid structures in determining the development of radiation damage; the nature of the metastable species formed.

C. V. R.

Optical Masers—*Supplement 2 of Advances in Electronics and Electron Physics—*L. Marton, Series Editor. By George Birnbaum. (Academic Press, New York and London), 1964. Pp. xi + 306. Price $ 9.50.

The demonstration, in 1960, of optical maser action in ruby launched a course of investigation and discovery so rapid that a need was created for a systematic account of experimental and theoretical results. This volume answers that need. It presents a synthesis of the extensive literature in a review of optical masers, their applications, and the theory underlying their use. Included among the specific subjects covered in this work are optical resonators, methods of excitation, spectral characteristics of maser materials, characteristics of various optical masers, and the multiple quantum effects produced by their radiation. This book will be useful to students and workers in the field of optical masers, and to all physicists and electronic engineers interested in the theory, behavior, and applications of this discipline.

C. V. R.

The Hormones: Physiology, Chemistry and Applications (Vol. 5). Edited by G. Pincus, K. V. Thimann and E. B. Astwood. (Academic Press, New York and London), 1964. Pp. x + 966. Price $ 28.00.

This work presents an exposition of contemporary developments in pituitary hormone chemistry and metabolic function. There are seven articles in this book whose titles with their respective authors are as follows: I. Chemistry of Pituitary Hormones, by H. B. F. Dixon; II. Metabolic Actions of Pituitary Hormones, by Frank L. Engel and Jack L. Kostyo; III. The Thyroid, by J. E. Rall, J. Robbins and C. G. Lewallen; IV. *In vivo* Studies of Steroid Dynamics in Man, by J. F. Tait and Shlomo Barstein; V. Tumors and Hormones, by R. L. Noble; VI. On the Action of Mammalian Hormones, by O. Hechter and I. D. K. Halkerston; and VII. Selected Problems in Endocrine Medicine, by Rachmiel Levine.

C. V. R.

Vitamins and Hormones (Vol. 22)—*Advances in Research and Applications.* Edited by Robert S. Harris, Ira G. Wool and John A. Loraine. (Academic Press, New York and London), 1964. Pp. xx + 940. Price 114 *sh.* 6 *d.*

This volume contains seven regular review articles, besides twenty-nine others which represent the communications delivered at an International Symposium on Vitamin B_6 held in honour of Professor Paul Gyorgy. The following is a list of the seven review articles and of their respective authors : 1. Biochemistry of Biotin, by S. P. Mistry and K. Dakshinamurti ; 2. The Biochemistry of the Inositol Lipids, by J. N. Hawthorne ; 3. The Role of Organ Cultures in the Study of Vitamins and Hormones, by Honor B. Fell ; 4. Therapy of Gynecological Disorders with Human Gonadotropin, by Carl Gemzell ; 5. The Biochemistry of Progesterone, by K. Fotherby ; 6. The Role of the Brain in the Regulation of Pituitary Gonadotropin Secretion, by E. M. Bogdanove ; and 7. Cellular and Molecular Aspects of the Antidiuretic Action of Vasopressins and Related Peptides, by Irving L. Schwartz and Linda M. Livingston.

<div align="right">C. V. R.</div>

Advances in Immunology (Vol. 4). Edited by F. J. Dixon and J. H. Humphrey. (Academic Press, New York and London), 1964. Pp. x + 478. Price $ 15.00.

This volume like its predecessors, contains reviews which range over the whole field of immunology, from a study of the biological origins of specific immunologic responses, through various aspects of their protective and pathogenic effects, to the present knowledge of the chemical structure of antibodies. This book contains seven important articles as listed below and contributed by twelve authors whose names are shown against each : 1. Ontogeny and Phylogeny of Adaptive Immunity, by Robert A. Good and Ben W. Papermaster ; 2. Cellular Reactions in Infection, by Emanuel Suter and Hansruedy Ramseier ; 3. Ultrastructure of Immunologic Processes, by Joseph D. Feldman ; 4. Cell-Wall Antigens of Gram-Positive Bacteria, by Macyln McCarty and Stephen I. Morse ; 5. Structure and Biological Activity of Immunoglobulins, by Sydney Cohen and Rodney R. Porter ; 6. Autoantibodies and Disease, by H. G. Kunkel and E. M. Tan ; 7. Effect of Bacteria and Bacterial Products on Antibody Response, by J. Munoz.

<div align="right">C. V. R.</div>

Absorption from the Intestine. By G. Wiseman. (Academic Press, London and New York), 1964. Pp. xvii + 564. Price 117 *sh.* 6 *d.*

In this entirely new treatise the author gives an account of the present-day knowledge of the absorptive and excretory functions of the gastrointestinal tract of man and laboratory animals. The book is dealt with in three sections. The first part contains the following articles : Epithelial Replacement in the Gastrointestinal Tract ; Gastric Evacuation Time ; Lymph.

The major section, Part Two, contains the following articles : Carbohydrate ; Protein ; Bile ; Fat ; Cholesterol and Phytosterols ; Water ; Sodium, Potassium and Chloride ; Calcium, Strontium, Magnisium and Phosphate ; Iron ; Copper, Cobalt and Manganese ; Aluminium, Zinc and Iodine ; Nickel and Tin ; Caesium ; Barium, Zirconium and Chromium ; Pantothenic Acid and Folic Acid ; Vitamin B_{12} ; Vitamin C ; Vitamin A and Carotene ; Vitamins D, E and K.

The concluding section, Part Three, contains the following articles : Defects of Absorption Following Operations on the Stomach ; Massive Resection of the Small Intestine ; Mal-absorption ; Macrocytic Anaemia in Blind Loop Syndrome ; X-Irradiation.

An appendix under the title "Absorption of Radioactive Isotopes by the Rat" is given at the end of the book.   C. V. R.

International Review of Experimental Pathology. Edited by G. W. Richter and M. A. Epstein. (Academic Press, New York and London).

Volume 2, 1963. Pp. xiii + 446. Price $ 16.00.
Volume 3, 1964. Pp. x + 432. Price $ 16.00.

Volume 2 of this series contains the following articles : The Nucleic Acids of Viruses Revealed by Their Reactions with Fluorochrome Acridine Orange, by Heather Donald Mayor ; Cytochemical Aspects of Experimental Leukemia, by B. Thorell ; A Lymphoma Syndrome in Tropical Africa, by Denis Birkitt with a Note on Histology, Cytology, and Histochemistry, by D. H. Wright ; The Use of Statistics in the Etiological Study of Malignant Neoplasms, by Johannes Clemmesen ; Biological Effects of Ionizing Radiations, by Arthur C. Upton ; Microscopic Morphology of Injured Living Tissue, by Ian K. Juckley ; Cellular Recognition of Foreign Matter, by Stephen Boyden ; Melanin Granules : Their Fine Structure, Formation, and Degradation in Normal and Pathological Tissues, by P. Drochmans.

Volume 3 of this series contains the following articles : The Use of Labelled Antibodies in Ultrastructural Studies, by G. B. Pierce, Jr., J. Sri Ram, and A. R. Midgley, Jr. ; The Mode of Reproduction of the Psittacosis-Lymphogranuloma-Trachoma (PLT) Group Viruses, by Noboru Higashi ; Ultrastructural and Subcellular Pathology of the Liver, by Jan W. Steiner, Melville J. Phillips, and Katsumi Miyai ; Ultrastructure of the Enamel Organ, by Ennio Pannese ; The Significance of the "Dying Back" Process in Experimental and Human Neurological Disease, by J. B. Cavanagh ; Intravascular Clotting : Focal and Systemic, by George D. Penick and Harold R. Roberts ; Experimental Production of Malformations of the Limbs by Means of Chemical Substances, by Berthe Salzgeber and Etienne Wolff ; Teratogenic Effects of Ionizing Radiations on the Embryonic Development of the Higher Vertebrates, by Jean-Michel Kirrmann and Etienne Wolff.

C. V. R.

Dover Publications, Inc., New York :

1. **Star Names : Their Lore and Meaning.** By Richard Hinckley Allen. Pp. xiv + 563. Price $ 2.35.

This edition, published in 1963, is a slightly revised republication of the original edition of 1899. The book touches upon not only all the constellations, but their important stars and such other groups as the Hyades, the Pleiades, the Great Nebula of Andromeda, and the Magellanic Clouds. It is completely non-technical, hence accessible to etymologists, anthropologists, and amateur stargazers. As the book contains a lot of unique reading material on early astronomical theory, even the practising astronomer will find it refreshingly new and instructive.

2. **Space and Time : In Contemporary Physics** —*An Introduction to the Theory of Relativity and Gravitation.* By Moritz Schlick. Pp. xii + 89. Price $ 1.00.

This is an unabridged, unaltered republication of the third (1920) edition. Beginning with some general comments as to the importance of the Einsteinian theory for the realm of physics, the author proceeds to explain the special principle of relativity, the inseparability of geometry and physics in experience, the relativity of motion and its connection with inertia and gravitation, the general postulate of relativity and the measure-determinations of the

space-time continuum, enunciation and significance of the fundamental law of the new theory, the finiteness of the universe, and the relation of the relativity theory to philosophy. Philosophers, teachers and students of philosophy or physics, and the general reader who wants to gain a basic understanding of the ideas within Einsteinian physics will profit by reading this book.

3. **The Friendly Stars.** By Martha Evans Martin. Pp. xii + 147. Price $ 1.00.

This minor classic, published more than 50 years ago, marshals the stars together in an engaging, non-technical survey, presenting them not as austere objects of scientific study, but as they should appear to all who love the open air. In this new, up-dated edition, completely revised by Dr. Menzel, the text has been made to conform to the latest knowledge without harm to its charming informality. Twenty-three diagrams of constellations have been redrawn by Professor Ching-Sung Yu of Hood College, who has also extended and revised the two star charts to include new and more accurate data on variable stars, nebulæ, and clusters. The Index is new to this edition.

V. S. Ramaswamy.

Techniques in Experimental Virology. Edited by R. J. C. Harris. (Academic Press. London and New York), 1964. Pp. xiii + 450. Price 100 *sh.* 0 *d.*

The present volume under review covers the subjects of plant, insects and animal viruses in detail from the standpoint of the experimental methods used for the study of their growth *in vivo* or *in vitro*, their purification, assay, serology, the determination of their interaction with the cell and their ultrastructure by electron microscopy.

Contributed by a team of thirteen experts in the field of plant, insect and animal virology, this volume meets the need of all those who require, in one volume, tested experimental methods for the use in the laboratory. The titles of the chapters contained in this volume are the following : Preparation and Properties of Plant Virus Proteins ; The Infective Nucleic Acids of Plant Viruses ; Assay of Infectivity ; Insect Viruses ; Purification of Animal Viruses ; Animal Virus Titration Techniques ; Serological Techniques ; Hemagglutionation ; The Infective Nucleic Acids of Animal Viruses ; Interference and Interferon ; Tissue Culture Techniques ; Ultrastructural

Studies ; Electron Microscopy of Viruses in Cells and Tissues.

C. V. R.

Methods in Hormone Research (Vol. IV)—
Part B: *Steroidal Activity in Experimental Animals and Man.* Edited by Ralph I. Dorfman. (Academic Press, New York and London). Pp. xii + 362. Price $ 13.00.

This volume deals with the methods pertaining to the newly discovered "non-hormonal" activities of steroids. Emphasis is given to protection against irradiation damage, anti-mammary tumor activity, influence on body lipids, antialdosterone, central depressant action, and copulatory reflex activity.

The book also provides documentation of these non-hormonal activities and of certain hormonal activities. A part of the process of fashioning more valuable therapeutic agents, and necessary to supply biological data on steroidal activities, these methods form the basis for understanding structure-activity and mechanisms of steroid hormone action.

The subject is dealt with in ten chapters whose titles are as follows : 1. Thermogenic Properties of Steroids ; 2. Anabolic Steroids ; 3. Anti-Androgens ; 4. Anti-Progestational Compounds ; 5. Steroids in Reactivated Prostatic Cancer ; 6. Steroids and Tumorigenesis in Experimental Animals ; 7. Inhibition of Tumor Growth by Steroids ; 8. Effects of Steroids on the Pancreas ; 9. Effects of Corticoids and ACTH on the Induction of Gastric Ulcers in Laboratory Animals ; and 10. The Influence of Steroids on β-Glucuronidase of Mouse Kidneys.

C. V. R.

Final-State Interactions. By John Gillespie. (Published by Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1965. Pp. 104. Price $ 6.95.

Various formalisms have been used by theoretical nuclear physicists to explain interactions among particles in the final state of scattering or production processes. Such formalisms have been developed with limited applications and with varying degrees of success, and are often understood only by the specialists in the field. The underlying purinciple in all these attempts is to conform to the basic hypothesis of unitarity, time-reversal invariance, and separable interactions.

The book under review is the first attempt to bring together in as clear a manner as possible the mathematical tools involved in theories connected with final-state interactions, and thus provide an introduction to the subject to workers in this field of research. Extensive use is made of the Jost-function formalism. Among the subjects treated are : Lippmann-Schwinger formalism ; Potential representation ; S-matrix methods ; Omnes-Muskhelishvili solutions ; Khuri-Treiman equation ; Faddeev equations ; Photodisintegration and Photodetachment.

A. S. G.

Interatomic Distances Supplement : Special Publication No. 18. (The Chemical Society, Burlington House, London W-I), 1965. Price £ 4-4 *sh.* or $ 12.00.

This is a Supplement to the original *Tables of Interatomic Distances and Configuration in Molecules and Ions,* published in 1958, as Special Publication No. 11 by the Chemical Society, London. The Supplement covers the period 1956-1969, and the entries have been made following the same general principles and rules as in the Main Volume. The Table of Selected Bond Lengths includes those of the Main Tables and is thus complete and corrected. The Supplement also includes Errata and Addenda to the Main Volume.

A. S. G.

Books Received

Advances in Genetics (Vol. 12). Edited by E. W. Caspari and J. M. Thoday (Academic Press, New York), 1965. Pp. viii + 388. Price $ 14.00.

Advances in Carbohydrate Chemistry. Edited by M. L. Wolform and R. Stuarttipson. (Academic Press, New York), 1964. Pp. xi + 415. Price $ 15.00.

Physics. By W. E. Hazen and R. W. Pidd. (Addison-Wesley Publishing Co., Reading, Massachusetts, U.S.A.), 1965. Pp. xii + 628. Price $ 11.75.

Progress in Chemical Toxicology (Vol. 2). Edited by A. Stolman. (Academic Press, New York), 1964. Pp. x + 416. Price $ 14.00.

Mathematics in Science and Engineering (Vol. 13)—*Stability of Nonlinear Control Systems.* By S. Lefschetz. (Academic Press, New York), 1965. Pp. xi + 150. Price $ 7.50.

Principles of Computation. By P. Calingaert. (Addison-Wesley Publishing Co., Reading, Massachusetts, U.S.A.), 1965. Pp. viii + 200. Price $ 7.50.

THE NEW PHYSIOLOGY OF VISION

Chapter XXV. The Colours of Natural and Synthetic Gemstones

Sir C. V. RAMAN

GLASSES exhibiting colour are made by the addition of the oxides of various metals to the materials used in their manufacture. Amongst the additives used for this purpose in different cases may be listed the oxides of copper, cobalt, iron, nickel, chromium, manganese, titanium and uranium. Black, blue, green, amber, yellow, orange, red, purple and violet are amongst the colours that have been produced. We begin the present article with a reference to coloured glasses for the reason that they afford excellent illustrations of the role played by the characteristics of human vision in the production and perception of colour.

A familiar example of the use of coloured glass is for signal lights, viz., red, yellow and green. It is essential for such use that the colours perceived should be highly pronounced and distinctive, and that the glass should transmit light of sufficient brightness for it to be readily perceived. Examination of the signal glasses used on railways shows how these requirements are met. It is found that the red signal-glass cuts off completely the blue, green and yellow sectors of the spectrum and transmits only wavelengths greater than 600 mμ. The "green" signal-glass actually appears bluish-green and exhibits a free transmission of wavelengths between 450 mμ and 560 mμ, in other words, part of the blue sector and the whole of the green but cuts out completely the yellow and red sectors of the spectrum. The yellow signal-glass shows a nearly complete extinction of the blue sector and transmits the rest of the spectrum without any noticeable absorption.

Blue glasses are of particular interest. Four specimens were examined which exhibited different depths of colour. All the specimens showed an absorption of the yellow over the wavelength range between 570 mμ and 600 mμ. This absorption was evident even in the case of the most lightly coloured specimen and progressed to a complete extinction in the case of the most deeply coloured glass. All the four specimens also exhibited an absorption band in the red located at 650 mμ and in addition a general absorption in the red region of the spectrum.

A weak absorption was also noticeable in the green between 510 mμ and 540 mμ and this was progressively stronger with increasing depth of the colour exhibited by the glass. In all cases, there was a free transmission in the green between 540 mμ and 570 mμ. This appeared in the case of the deep blue glass as a bright band in the spectrum with dark bands on either side of it.

In the collection of specimens of glass presented many years ago to the author by the American Optical Company, there is a piece of spectacle glass which exhibits a brilliant blue-green colour by transmitted light. The spectroscope reveals that this colour results from a free transmission of the blue and the green sectors of the spectrum and a complete cut-off of the yellow and the red sectors. This specimen as well as the other cases mentioned above illustrate the extremely important role played by the yellow sector of the spectrum in the perception of colour. Only when the yellow sector has been completely eliminated by absorption can red, green or blue manifest themselves to perception as highly chromatic sensations.

Blue glasses also illustrate the general principle that in the perception of colour, strong sensations may mask sensations which are much weaker and prevent their being perceived. Thus, when the yellow has been eliminated, the blue sensation becomes dominant and prevents the green and the red from being perceived even though they are present in the spectrum. In general, however, composite sensations are experienced, the nature of which is determined by the particular circumstances of the case.

Colours of Synthetic Corundum.—As is well known, cylindrical boules of crystallised alumina can be prepared by the Verneuil process which are perfectly colourless and transparent if pure alumina is employed, but can also be made exhibiting varied colours by the use of appropriate additives. A collection of such boules prepared by an Indian manufacturer was available for study. The collection included fourteen colourless boules besides an equal number of specimens showing various

colours, *viz.*, three blues, one yellow, four greens, two purples and four reds. We shall proceed to describe the results of a study of these specimens.

The three *blues* showed essentially the same spectral pattern of absorption but developed to different extents. All the three specimens showed an extinction of the yellow of the spectrum in the wavelength range 570 mμ to 600 mμ. Two other bands of absorption were also observed, one in the green from 540 mμ to 550 mμ and another in the red from 630 mμ to 660 mμ. The parts of the spectrum in the green, orange and red which were actually transmitted had apparently no effect on the colour of the light perceived which was a clear blue for all the specimens though the luminosity varied from specimen to specimen.

The *yellow* boule showed a rather pale colour which was the result of a diminished transmission of the blue region of the spectrum. The four *green* boules also did not exhibit that colour in any striking fashion. Both the red and the blue sectors showed a diminution of intensity in the transmitted light, and the yellow was also weakened. But in the net result, the green sector did not show any particular degree of prominence in the spectrum. The poverty of the resulting colour was therefore not surprising.

Of the two *purple* boules, one was of a much deeper colour than the other. But even the faintly coloured specimen showed a readily observable diminution in the intensity of the yellow sector relatively to the rest of the spectrum. The more strongly coloured specimen showed a nearly complete extinction of the yellow of the spectrum over the wavelength range from 560 mμ to 600 mμ, while the red, green, and blue sectors maintained their normal relative intensities.

The *red* boules owed their colour to an absorption of light manifesting itself in the wavelength range between 500 mμ and 600 mμ. Two of the boules which were optically clear and perfect showed the phenomenon of dichroism in a very striking fashion. The colour of the boule as seen by transmitted light showed a large change when it was viewed transversely and rotated about its cylindrical axis. In one position, the colour was a rose-red, the spectrum exhibiting a relatively weak absorption in the green with its maximum around 550 mμ. In the other position, the colour was a deep purplish-red and the absorption was practically complete over the wavelength range from 500 mμ to

600 mμ, thus covering both the green and yellow regions in the spectrum.

Colours of Natural Corundum.—As is well known, the gravel-beds below the soil in the vicinity of Ratnapura in Ceylon have for many years been the source of gemstones of various sorts. Some years ago, while on a visit to Ceylon, the author was the recipient of a generous presentation of some hundreds of specimens of the materials found at this site. They were sorted out and preserved and have been made use of for the observations presently to be described. Many of the specimens were colourless and some of them were so heavily coloured as to be nearly opaque. Excluding these, the rest of the material could be classified in the following colour-groups: blue, purple, red, green and yellow. Under an ultra-violet lamp, these groups behaved quite differently. The blue and green specimens were non-luminescent. The purple and the red stones showed a red glow of varying degrees of brightness, while the yellow specimens exhibited an orange luminescence.

Spectroscopic examination of the transmitted light showed that the blue stones owed their colour to a more or less complete extinction of the yellow sector of the spectrum and a cut-off of wavelengths greater than 650 mμ at the red end of the spectrum. The spectroscope also revealed that the characteristic purple colour exhibited by numerous specimens in the collection had its origin in the powerful absorption exhibited by these specimens in the wavelength range between 560 mμ and 600 mμ, in other words, of the yellow part of the spectrum, while the blue, green and red sectors remained conspicuously visible.

The red stones in the collection are rather small and of irregular shape, and also not optically clear. The difficulties arising from these defects in the study of their spectroscopic behaviour were overcome by setting each specimen in an aperture made in an opaque screen. Holding this close to a brilliant source of white light, enough light diffuses through the specimen to enable its spectral character to be observed. The spectrum observed in this fashion differs from specimen to specimen, and *pari passu* there is a variation in the colour of the emerging light and of its brightness. Certain general features were however noticeable. In all cases, the red sector of the spectrum emerged freely. Certain sharply-defined absorption lines appeared in the region of greatest wavelengths, but despite such absorption, the red

remained the brightest part of the spectrum. The spectral region between 500 mμ and 600 mμ also exhibited absorption. But the strength and the spectral range of this absorption varied from specimen to specimen. As a consequence of the weakening of the green and yellow sectors in the spectrum, the red becomes dominant and determines the observed colour. In this, it is aided by the absorption noticeable in the region of shortest wavelengths in the blue sector.

The "green" stones in the collection could be more accurately described as greenish-yellow. They owed their colour to a strong absorption of the light in the blue and blue-green parts of the spectrum and to a very noticeable weakening of the red sector. The "yellow" stones owed their colour to a partial absorption of the blue sector, the rest of the spectrum remaining unaffected.

The Green Colour of Emerald.—The variety of beryl known as emerald shares with ruby and sapphire the rank of 'precious stone' in the popular estimation and, as with the corundum gems, its rarity and costliness have served to stimulate man's ingenuity in providing artificial substitutes. Just as the red of ruby and the blue of sapphire cannot be properly matched by any other natural mineral, so is the pure emerald green unequalled by any other transparent natural gemstone.

Beryl is a silicate of beryllium and aluminium and the colour of emerald is due to traces of chromium, which replaces to a small extent the aluminium ions in the crystal lattice of the hexagonal lattice of the hexagonal beryl crystal. It is a feature of this colouring agent which also causes the red in ruby and in spinel and the betwixt-and-between colour in alexandrite, that even when it produces a green colour, it transmits a proportion of deep red light.

The foregoing quotations from B. W. Anderson's book on "Gem Testing" state very clearly the reasons why the emerald is held in such high esteem, *viz.*, its beautiful green colour and the rarity of material of the requisite high quality, which together make it a much-valued gemstone. It should be mentioned that beryl is itself a mineral of fairly common occurrence and that though it is colourless in the pure state, it frequently exhibits colour, this presumably arising from the presence of impurities. Iron is the impurity responsible for the familiar bottle-green colour of cheap glassware; oxides of iron if present in beryl as impurities would

also give it a green colour. But it is not difficult to recognise the special variety of beryl in which the colour arises from the presence of chromium as an impurity. Spectroscopic examination reveals the presence in such cases of a group of sharply-defined absorption lines falling within the wavelength range between 600 mμ and 700 mμ, and indicating the presence of chromium in the crystal lattice.

The author had at his disposal an extensive collection of beryl specimens including especially several which had a green colour. A few of these were large and clear enough to permit of the absorption spectrum being seen by merely holding up the specimen against the sky and examining the transmitted light through a pocket spectroscope. In most cases, however, the specimens were either too small or else were not optically clear enough to permit of their being thus dealt with. In such cases, the specimens were set within an aperture in an opaque screen and this was held close up to a brilliant source of white light. The light emerging through the material could then be conveniently examined. To make the present study more complete, the author used besides the beryls at his disposal, also a real emerald of small size but of good quality and two specimens of the well-known synthetic product made by Mr. Carroll F. Chatham of San Francisco and marketed under the trade name of "Chatham Created Emerald".

The comparative study of these specimens made it evident that the beautiful green colour of emerald owes its origin to the absorption of the yellow sector, in other words, of the wavelength range in the spectrum between 560 mμ and 600 mμ. The more complete this absorption is, the more striking is the green colour which results. The removal of the yellow sector and the simultaneous weakening of the blue and red sectors leaves the green as the dominant feature which determines the observed colour. It should be remarked that the blue and red sectors are not completely extinguished in any case. But they are so weak that they are masked by the stronger green and prevented from being perceived. The larger of the two Chatham emeralds examined by the author shows the absorption of the yellow sector in a particularly striking fashion. The red sector, though weakened, is also very clearly seen and exhibits the characteristic absorption lines due to the chromium impurity with extreme sharpness and clarity.

NUCLEAR STRUCTURE EFFECTS ON INTERNAL CONVERSION COEFFICIENTS

R. P. SHARMA AND B. V. THOSAR

Tata Institute of Fundamental Research, Bombay-5, India

INTRODUCTION

IN the internal conversion process the de-excitation energy E of a nucleus is directly transferred to one of the orbital electrons. The electron emerges out with an energy $E-E_n$, where E_n is the binding energy of the electron and it carries away the spin and parity changes involved in the transition between the nuclear states. The ratio of the conversion electron intensity to the competing gamma-ray intensity is known as internal conversion coefficient. The coefficients in general depend on the energy of the transition, the atomic number of the transforming nucleus, the multipole order of the transition and the atomic shell (K, L_1, L_{11}, etc.) in which the conversion takes place. Thus the internal conversion process has been used to determine the spin and parity properties of the nuclear states.

Theoretically the internal conversion coefficients were first calculated by Rose[1] on the basis of point nucleus approximation. Sliv[2,3] pointed out the effect of the finite size of the nucleus on the electron wave function and his calculated values[4] included these effects. Later on the effect of the finite size of the nucleus was also incorporated by Rose[5] in his calculations. The effect of the penetration of the electron inside the nuclear volume has been extensively considered by Church and Weneser[6] and by Green and Rose.[7]

NUCLEAR FINITE SIZE EFFECT

The nuclear structure effect on the internal conversion process can be understood by considering the details of the interaction between the orbital electron and the nucleus. This interaction takes place *via* the radiation field, the strength of which is proportional to the gamma-ray matrix element where the nuclear structure-dependent factors are included. If this interaction is considered as confined only to outside the nuclear volume, the internal conversion coefficient being a ratio, it is independent of the details of nuclear structure. However, the orbital electron does penetrate the nuclear matter for a short while where it interacts with the nuclear transition charges and currents. This gives rise to "penetration matrix elements" which may not be proportional to the gamma-ray matrix elements.

The finite size effect has been considered in two parts. The static effect in which the penetration matrix elements are neglected in comparison with the normal conversion matrix elements and the finite size effect removes the point nucleus singularity at the origin and gives rise to a slight distortion of the electron wave function. The other part is the dynamic effect[6] in which the penetration matrix elements cannot be neglected. The electron nuclear interaction inside the nuclear volume then becomes predominant and it is not of the same form as in the outside region. Such a situation arises when due to some selection rule the gamma transition is retarded (*e.g.*, *l*-forbidden M 1 transition), while the conversion process in the interior of the nucleus remains unaffected. This results in a large reduction of the normal conversion matrix element. Under such circumstances the penetration matrix elements cannot be neglected and the finite size effects on internal conversion process are considerable.

It has been observed that all the above considerations are much less effective for electric transitions. Only in the case of certain hindered E 1 transitions the finite size effect is predominant. E 2 transitions remain least affected by the static and dynamic effects of nuclear structure. This will be more clear if we examine the internal conversion of M 1 and E 2 transitions in the K-shell. The K-shell electron is in $S_{1/2}$ state and for any angular momentum transfer with or without parity change there will be two final continuum states. The M 1 and E 2 conversion can be written as follows:

	Bound state		Final state
M1	$S_{1/2}$	$\longrightarrow$	$\begin{cases} s_{1/2}\,(\chi=-1) \\ d_{3/2}\,(\chi=+2) \end{cases}$
E2	$S_{1/2}$	$\longrightarrow$	$\begin{cases} d_{3/2}\,(\chi=+2) \\ d_{5/2}\,(\chi=-3) \end{cases}$

The conversion coefficients of these transitions can be expressed as the sum of the two partial conversion coefficients one for each of the two final states as given by Rose.[8]

$$a_k(M1) = \frac{2\pi a k}{3}\{2\mid R_{-1}\mid^2 + \mid R_{+2}\mid^2\}$$

$$a_k(E2) = \frac{\pi a k}{15}\{3\mid R_{-3}\mid^2 + 2\mid R_{+2}\mid^2\}$$

In these expressions R_χ represent the electron radial matrix elements. Taking the case of M 1 conversion it is evident that the transition $s_{1/2} \to s_{1/2}$ is the predominant one and is strongly affected by finite nuclear size. For E 2 transitions, due to the cancellation in the radial matrix elements for the $s_{1/2} \to d_{3/2}$ transition, the dominant transition is to the state of higher j and is expected to be practically unaffected by finite size effects.

<div align="center">SOME EXPERIMENTAL MEASUREMENTS AND RESULTS</div>

Various measurements of internal conversion coefficients and also e-γ and γ-γ directional correlation have been carried out to determine the possible nuclear structure effects in different nuclei. These measurements have confirmed the nuclear structure effects in the l-forbidden M 1 transitions in odd mass T 1-isotopes[9,10] and also in hindered E 1 transitions[11] in some deformed heavy nuclei.

In the case of E 2 transitions the situation has been different. As is evident from the above discussion the internal conversion coefficients of E 2 transitions are not affected by nuclear finite size, and this has been experimentally confirmed[12] in certain spherical nuclei such as Au^{198}. But there existed some experimental evidence[13-15] that in the even-even rare-earth nuclei the conversion coefficients of $2^+ \to 0^+$ transitions were higher by 20 to 30% than the corresponding theoretical values. As these nuclei are deformed, it was thought that the nuclear deformation might affect the E 2 conversion process. Theoretically it has not been possible to explain the above anomaly. However, since the energy of these transitions is less than 100 keV in most cases and the nuclei are complex, the experimental uncertainties might also be large. In view of this we give a summary of some careful measurements, carried out by us[16] and by several other groups[17,18] which indicate that the earlier deviations appear to be due to experimental causes rather than any new effect of nuclear structure. The K-shell conversion coefficients of such E 2 transitions have been measured by the following techniques :—

(1) Scintillation method— (Singles and coincidence). In this method comparison between the gamma-ray intensity and corresponding X-ray intensity following internal conversion is carried out.

(2) Absolute intensity measurement of e– and γ using high resolution beta-ray spectrometer.

(3) Internal-external conversion method, where the ratio of the intensities of the conversion line and the photo line as observed in a high resolution spectrometer is determined. The photo line is obtained due to the photoelectric absorption of the gamma-ray in an external converter which is placed in front of the source.

The scintillation technique is quite suitable for the gamma transitions under consideration, as they are very intense and being of low energy (< 100 keV) their conversion coefficient is large. A clear gamma-ray photopeak and the corresponding K-X-ray peak following the internal conversion are observed in a scintillation spectrum when studied on a NaI (T 1) crystal. This low energy part of a singles gamma spectrum will have contributions from (*a*) bremsstrahlung produced by the high energy beta particles in the beta absorber, (*b*) Compton distribution produced in the crystal due to the detection of high energy gamma-rays, (*c*) scattering from the surroundings, (*d*) escape peak of the gamma-ray observed at an energy which is 28 keV less than the photopeak and is due to the escape of the iodine K-X-ray produced by the photoelectric absorption of the low energy gamma-ray in the first few top layers of the NaI (T 1) crystal, (*e*) internal conversion of other gamma transitions and (*f*) possible K-capture decay of the parent nucleus in certain cases or any trace of K-capture impurity. The first three contributions affect both the γ-ray and the X-ray intensities while the remaining ones only the X-ray intensity. Thus the measurement of conversion coefficient from singles spectrum may be quite uncertain.

In a coincidence measurement such as the gamma scintillation spectrum being observed in coincidence with suitable energy beta-rays focussed in a high transmission beta-ray spectrometer, all the above-mentioned contributions except the escape peak and the scattering from the surroundings are eliminated. These two can be experimentally determined by using a suitably graded shadow shield (Cd, Mo, Cu) or (Ta, Cd, Mo, Cu) to absorb the direct X-rays for escape peak determination, and both direct X-rays and γ-rays for the determination of the scattering from the surroundings and then repeating the coincidence measurement. Such a beta-gamma coincidence measurement in the case of $Tm^{170} \to Yb^{170}$ is shown in Fig. 1. In cases where there is no beta feeding to the first 2^+ excited state the desired transition can be observed in coincidence with the highest energy

gamma-ray or the capture K-X-ray to avoid the above-mentioned contributions. Such measurements have been carried out in this
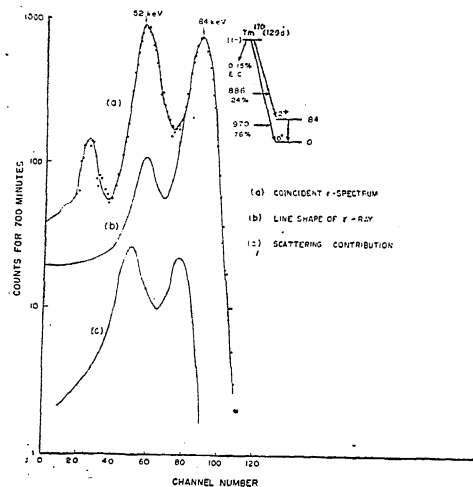

FIG. 1. The gamma spectrum in coincidence with 600 keV beta-rays as observed in the decay $Tm^{170} \rightarrow Yb^{170}$. The gamma line shape and the contribution due to scattering from the surroundings obtained by using suitably graded shadow shields are also shown.

laboratory and the results in a number of rare-earth nuclei are summarised in Table I. Small corrections arising due to the angular distribution of the gamma-rays have been taken into account.

TABLE I

K-shell internal conversion coefficients for pure E 2 transitions

Nuclei	Energy, keV $2^+ \rightarrow 0^+$	Method	α_k (Exp.)	α_k (Theo.)
Er^{166}	80·57		1·67± ·07	1·60
Yb^{170}	84·23		1·30± ·08	1·33
Hf^{176}	88·35	β-γ coincidence	1·10±0·07	1·08
Os^{186}	137·0		0·42±0·03	0·428
Os^{188}	155·0		0·35±0·03	0·33
Eu^{156}	88·9	γ-γ coincidence	1·41±0·05	1·40
Dy^{160}	86·7		1·48±0·08	1·51
W^{186}	122·0	X-γ coincidence	0·55±0·03	0·578

In some of the above-mentioned cases the earlier measurements as carried out by internal-external conversion technique had yielded α_k values[14] which were ~ 20% higher than the corresponding theoretical values. It may be mentioned that in this method there are certain uncertainties which are very important in the low energy region. These are due to (a) photoelectron angular distribution and its effect on the photoelectric absorption cross-section, (b) scattering in beta-absorber,

(c) ratio of the internal and external source strengths and (d) difference in geometries in internal and external measurements. Recently Erman and Hultberg[18] have taken into account the corrections due to scattering in the external converter more accurately. They have also employed a technique in which it is possible to use the same source for both the internal and external conversion lines and the geometrical corrections are determined experimentally. The values of α_k as obtained by them in Dy^{160}, Er^{166}, Yb^{170} and W^{182} for $2^+ \rightarrow 0^+$ transitions are in agreement with the theory.

The information regarding the K-shell conversion coefficients can also be obtained from the measurement of K-X-ray yields produced by the K-ionisation and Coulomb excitation of the deformed nuclei by the bombardment of α-particles. In fact these were the first measurements by McGowan and Stelson[13] where a higher K-X-ray yield in the atoms of deformed nuclei was interpreted as due to higher internal conversion. Such measurements have also been repeated by us by placing the detector suitably facing the bombarded surface of the target without any intervening material except the crystal top and very accurately focusing the α-beam from Van de Graaff generator, on the target. The measurements[19] of X-ray yields due to K-ionisation in Sn, Te, Ce, Sm^{144}, Sm^{152}, Sm^{154}, Gd^{160}, W^{186} and Pb do not indicate any excess of X-ray yields in deformed nuclei (Fig. 2). The comparison of results in Sm^{144}
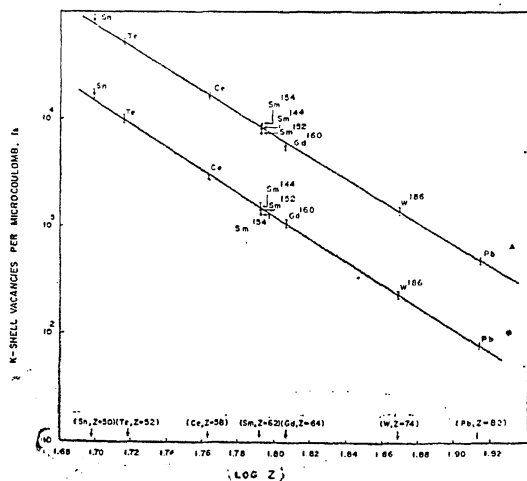

FIG. 2. The plot of log I_K versus log Z for the incident α-particle energy (A) 4 MeV and (B) 3 MeV. I_K, the number of K shell vacancies per microcoulomb, is the yield of K-X-rays measured at an angle of 54° with respect to the incident beam and corrected for the fluorescent yield.

which has a spherical nucleus with those in Sm[152] and Sm[154] which have deformed nuclei brings out the above conclusion more clearly.

Thus it may be seen that the anomaly regarding the K-shell conversion coefficients of $2^+ \rightarrow 0^+$ transitions in deformed even-even nuclei is getting resolved and it seems that the E2 internal conversion process is unaffected by nuclear structure. Any unknown effect due to nuclear deformation, if present, has to be less than 6-7%.

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MORPHOLOGY AND ONTOGENY OF THE ETHEREAL OIL CELLS IN *SCHISANDRA* MICHAUX.

S. JALAN*

Department of Botany, University of Delhi, Delhi (India)

THE genus *Schisandra* comprises 22 species distributed in the south-eastern areas of the Northern Hemisphere. Although much work has appeared on its embryology (*see* Hayashi,[5] Kapil and Jayan[9]), palynology (Erdtman,[3] Jalan and Kapil,[8] Wodehouse[12]), stomata (Jalan[7]), and systematic position (Jalan[6]), anatomical observations are still meagre and insufficient. The present investigation deals with the structure and development of the ethereal oil cells in *Schisandra* Michaux.

Portions of the root, stem, leaf, and various floral parts of *Schisandra grandiflora* and *S. neglecta* were collected from several localities in Eastern and Western Himalayas (*see* Jalan[6]). The ethereal oil cells were examined mostly by peeling off strips of cuticle as outlined by Bailey and Nast.[1] Whole-mount preparations of young leaves were also made.

The ethereal oil cells occur on both vegetative and reproductive organs. They are most abundant on the leaves being confined to the lower surface and distributed in a mosaic fashion. In general, two categories of oil cells may be recognised, namely, epidermal and sub-epidermal. The latter occur in the deeper layers of the cortex, pith, stamens, carpels, and in the mesophyll tissue of the leaves. The epidermal cells adjoining the ethereal oil cells are disposed in a rosette fashion.

Both in *Schisandra grandiflora* and *S. neglecta* the epidermal ethereal oil cells of leaves are more or less spherical (Figs. 3, 6), while those found in the epidermal or sub-epidermal layers of the stem or petiole are polyhedral (Figs. 4, 5). In surface view the oil cells are relatively small as compared with the surrounding epidermal cells (Figs. 4-6). Structurally, each oil cell contains a single nucleus imbedded in the vacuolated cytoplasm. In general, the nuclei of the ethereal oil cells resemble those of the surrounding cells. However, the nucleoli of the former are more prominent and the nuclear membranes stain more deeply as compared with those of the nuclei of the non-secretory cells. Also, the nucleoli in the ethereal oil cells vary in number and size. Figures 2, 3 show nuclei with four and six nucleoli respectively; in a few instances as many as eight nucleoli were also observed in each nucleus. This is in

accordance with the findings of Zirkle[13] who also noted variations in the number of nucleoli in the secretory cells of *Pinus strobus*.
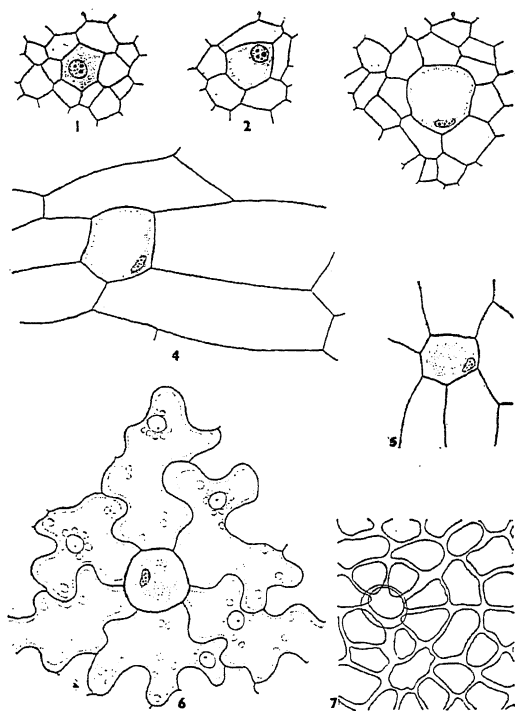
FIGS. 1–7. Figs. 1–3. Stages in the development of ethereal oil cells, × 580. Fig. 4. Surface view of ethereal oil cell in the epidermis of the stem, × 580. Fig. 5. Same, from the petiolar epidermis, × 580. Fig. 6. A mature ethereal oil cell from the lower epidermis of the leaf; note rosette of surrounding epidermal cells, × 580. Fig. 7. 'Hair scar' on leaf, × 560 (After Rao, 1939).

The ethereal oil initials appear more or less simultaneously with the stomatal mother cells in the young leaf primordia. However, in contrast to the latter, the oil cells arise directly from the protodermal cells. There is no indication that the division preceding the formation of oil cell initials is a differential division, as in the development of the trichosclereid initials of *Monstera* (Bloch[2]) or of other idioblasts (see Foster[4]). Although most ethereal oil cells arise early in the very young leaf primordia, some may also develop later when the stomata are already fully mature.

In the beginning, the ethereal oil cells are polygonal, somewhat larger than the neighbouring protodermal cells, and are characterised by dense cytoplasm and prominent nuclei (Fig. 1). They also show a distinct avidity for cytoplasmic and nuclear stains. Soon they become more or less spherical (Figs. 2, 3). Simultaneously, vacuoles appear in the cytoplasm. They eventually fuse and push the cytoplasm against the cell-wall (Figs. 1–3), and the nucleus becomes elongated. The wall of the ethereal oil cells is slightly thicker than that of the adjoining cells (Figs. 1–6). Its cytoplasm takes a lighter stain than that of the neighbouring cells of the epidermis. However, as mentioned earlier, the nuclear membrane and the nucleoli stain more deeply.

Rao[10] mistook the ethereal oil cells as hair scars, and remarked : "....hair scars when present are observed usually on the lower surface and in *Kadsura scandens* on the upper surface also." His Fig. 103 (reproduced here as Fig. 7) really shows the oil cells surrounded by rosettes of epidermal cells. It may also be noted that none of the species of *Schisandra* or *Kadsura* are pubescent (see Smith[11]) and, therefore, the presence of hairs or hair scars is out of question. The hair scars reported by Rao in some species of *Magnolia* and *Manglietia* are also probably ethereal oil cells.

* Present Address : Department of Botany, University of Rajasthan, Jaipur (India).

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LETTERS TO THE EDITOR

ON THE DEGREE OF CENTROSYMMETRY OF A NON-CENTROSYMMETRIC STRUCTURE *

It is well known that the two basic statistical distribution laws governing X-ray intensities of a centrosymmetric and a non-centrosymmetric crystal derived by Wilson[1] tend to be violated under a variety of conditions, such as for instance when a few of the atoms have predominantly larger scattering power than the rest or when some of the atoms occupy special positions in the unit cell and so on. The distributions also tend to be affected by the presence of any pseudosymmetry in the structure. We use the term pseudosymmetry in a rather general sense to signify the presence of any symmetry property associated with the structural unit† such as to invalidate the assumption of random distribution of atoms in the unit cell. A variety of pseudosymmetries would then be possible. For instance, symmetry elements of an exact type, such as one or more of centre of inversion, may be present in the unit which leads to different types of hyper-centrosymmetric distributions.[2,3] We may also have cases when symmetry associated with the unit is not of an exact type as for instance in the case of feldspars[4] where a part of the unit is obtained by the translation from another *plus* small deviations in the atomic co-ordinates. This may be categorized under translational pseudosymmetry.

Another type of pseudosymmetry possible and which does not appear to have been considered earlier in literature is when a part of the unit possesses symmetry of an exact type the remaining part having no symmetry at all. A special case of this, which is of considerable practical interest, is when a molecule, a major portion of which is centric, the remaining portion being acentric‡ makes up the unit and takes the non-centrosymmetric space group P 1. It is clear that in such a case, it should be possible to talk of the "degree of centrosymmetry" of the structure, since the distribution of intensities could be expected to depend on the relative proportion of the two parts. This particular problem has been considered by the author.[5] In fact, the result for this case comes

out as a special case of the problem which has been considered more generally, namely the problem of the distribution of intensities for a structure containing n_1 centric and n_2 acentric groups in random orientations in the unit cell. The special case mentioned above actually corresponds to $n_1 = n_2 = 1$. The purpose of this note is to briefly outline the main results thus obtained, details of which are given in the paper cited above.[5]

In the discussion to follow, we use the following notations. σ_N^2 and σ_C^2 stand for the mean square value of the contribution to the intensity from the entire acentric and centric parts respectively, n_1 and n_2 denote the numbers of centric and acentric groups respectively. The following cases arise.

When $n_1 = 0$, and n_2 is finite, the resultant distribution tends to the acentric one. This is obviously a trivial case, since any number of acentric groups would obviously lead only to a final acentric distribution. When $n_2 = 0$ and n_1 is large, the distribution again tends to the acentric one. This, again, is obvious from central limit theorem. The case of interest will be when $n_2 = 0$ and n_1 is small. Here again when $n_1 = 1$ the result is trivial since when only one centric group is present the resultant distribution becomes centric. The case when $n_2 = 0$, $n_1 = 2$ is shown in Fig. 1, where the probability distribution of the normalised structure
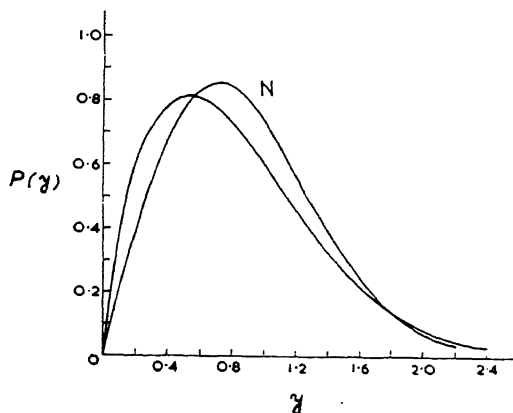

FIG. 1. The distribution of normalised structure amplitude for a non-centrosymmetric structure containing two centric groups. The ideal non-centrosymmetric curve is marked *N*.

amplitude[6] $y = |F|/<|F|^2>^{\frac{1}{2}}$ is shown. The distribution, for this case, is surprisingly very close to the non-centrosymmetric distribution $_NP(y)$ (marked N in Fig. 1). This would mean that, in practice, even if one has a symmetric molecule, so long as there are at least two of them in the unit cell randomly oriented, the distribution is close to the ideal acentric one. This result makes it unnecessary to consider cases when $n_2 > 2$. So also, when both n_1 and n_2 are finite, it is enough to consider the case when $n_1 = n_2 = 1$. The distribution $P(y)$ for this case is shown in Fig. 2, for different values of σ_1^2
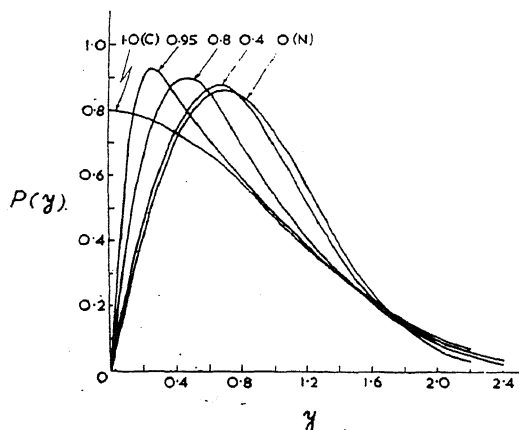

FIG. 2. Curves showing the degrees of centrosymmetry of a structure containing one centric and one acentric groups. The value of σ_1^2 is marked near each curve. $\sigma_1^2 = 1\cdot0$ and 0 correspond to ideal centrosymmetric (C) and non-centrosymmetric (N) cases respectively.

where σ_1^2 stands for the ratio $\sigma_C^2/(\sigma_C^2 + \sigma_N^2)$, When $\sigma_1^2 = 1\cdot0$ it tends to the ideal centric curve (C) while when $\sigma_1^2 = 0$ it tends to the ideal acentric curve (N). For intermediate values of σ_1^2 the curves fall in between the two limiting ones and may be taken to represent different 'degrees of centrosymmetry' of the structure.

The last two cases discussed above lead us to the conclusion that the intensity distribution for the case of a structure containing an "almost centrosymmetric" molecule would be practically unaltered from the acentric one so long as there are at least two of them in the unit cell. This is likely to be a case of frequent occurrence in practice, since molecules containing benzene ring and a few additional atoms appended to them very often crystallize in the space group $P2_1$ with two molecules in the unit cell.

I wish to thank Professor G. N. Ramachandran for helpful criticism.

Centre of Advanced   R. SRINIVASAN.
   Study in Physics,
University of Madras,
Madras-25, India, *July* 22, 1965.

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† The term structural unit or simply the unit, for brevity, is used in preference to the conventional term asymmetric unit since the latter is ambiguous in the present context.

‡ We use the terms centric and acentric as shortened versions of centrosymmetric and non-centrosymmetric respectively.

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OXIDATION OF THIOGLYCOLIC ACID USING CHLORAMINE-T

THE mechanism of the oxidation of thiols to disulphides has received considerable attention.[1] The iodimetric titration of thioglycolic acid,[2] cysteine[3] and other compounds containing thiol groups has been investigated by several workers. Mild oxidising agents convert the –SH group to the corresponding disulphide, while the oxidation could proceed further with stronger oxidants. Reports about the use of chloramine-T as an oxidant have shown that elemental sulphur[4] and its oxyanions[5,6] can be oxidised to sulphuric acid. The present investigations report about the possibilities of using chloramine-T as a volumetric reagent for estimating thioglycolic acid in aqueous and alcoholic solutions.

About 0·5 gm. of E. Merck sample thioglycolic acid (approximately 80% solution) was dissolved in 250 ml. of deaerated distilled water and alcoholic solutions were prepared by dissolving almost the same amount of thiolic acid in 95% alcohol (redistilled). The thioglycolic acid content of the aliquots was estimated by the iodimetric method.[2] An approximately decinormal chloramine-T solution was standardised by the method of Bottger and Bottger.[7]

PROCEDURE

(i) To an aliquot portion of thioglycolic acid solution (aqueous or alcoholic), 2 ml. of starch-potassium iodide mixture was added and the resulting solution was titrated against chloramine-T, to the appearance of a

pale blue colour. In titrations with alcoholic solutions, about 20 ml. of distilled water were added towards the end, for a sharp end point. From the titre values the number of equivalents of oxidant consumed by a mole of thioglycolic acid was calculated. The blank titres in either case were within 0·05 ml. of the oxidant.

(ii) An aliquot portion of aqueous thioglycolic acid solution was added to a mixture of 25 ml. decinormal chloramine-T and 10 ml. of 2 N HCl in an Erlenmeyer flask. The air inside the flask was displaced by a stream of pure CO_2 gas. The flask was stoppered and kept aside for 3 hours. The excess chloramine-T was then estimated by the iodimetric method using standard sodium thiosulphate solution.

The results are summarized in Tables I, II and III.

TABLE I

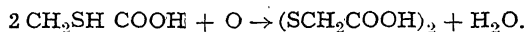*Titration of aqueous thioglycolic acid with chloramine-T*

Expt. No.	Amount of thioglycolic acid taken $\times 10^5$ moles	No. of equivalents of oxidant consumed $\times 10^5$	No. of equivalents of oxidant per mole of thioglycolic acid
1	11·9	12·9	1·08
2	11·9	12·9	1·08
3	23·8	26·9	1·13
4	47·6	51·6	1·08
5	59·5	66·2	1·11
6	71·4	79·6	1·12

TABLE II

Titration of alcoholic thioglycolic acid solution with chloramine-T

Expt. No.	Amount of thioglycolic acid taken $\times 10^5$ moles	No. of equivalents of oxidant consumed $\times 10^5$	No. of equivalents of oxidant per mole of thioglycolic acid
1	11·2	11·26	1·010
2	11·2	11·19	0·998
3	22·3	22·38	1·003
4	33·5	34·90	1·040
5	44·6	44·75	1·010
6	55·8	57·28	1·030
7	66·9	69·81	1·040

The results of Tables I and II indicate that each mole of thioglycolic acid consumes one equivalent of the oxidant corresponding to the oxidation of sulphhydryl group to the disulphide.

$$2 CH_2SH\ COOH + O \rightarrow (SCH_2COOH)_2 + H_2O.$$

The analytical results were found to be reproducible even in the presence of mineral acids.

TABLE III

Oxidation of aqueous thioglycolic acid by excess chloramine-T

Expt. No.	Amount of thioglycolic acid taken moles $\times 10^5$	No. of equivalents of oxidant consumed $\times 10^5$	No. of equivalents of oxidant per mole of thioglycolic acid
1	5·0	30·3	6·06
2	7·5	45·8	6·11
3	12·6	75·8	6·02
4	15·1	91·3	6·04
5	20·1	121·7	6·05
6	25·1	149·5	5·96

The oxidation of thioglycolic acid by excess chloramine-T seems to be a promising method for the volumetric estimation of the thiol. The results in Table III show that each mole of thioglycolic acid consumes 6 equivalents of the oxidant. This could mean that the oxidation might be proceeding beyond the disulphide stage leading to a sulphonic acid.

$$CH_2SH\ COOH + 3\ O \rightarrow CH_2.SO_2.OH.COOH$$
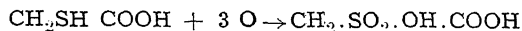
The results were reproducible only with aqueous solutions of thioglycolic acid. It is probable that side reactions may be more prominent in alcoholic solutions of thioglycolic acid.

The author is thankful to Prof. A. R. Vasudeva Murthy for helpful discussions and to Prof. M. R. A. Rao for providing research facilities at the Indian Institute of Science, Bangalore, where part of this work was carried out.

Dept. of Post-Graduate   D. S. MAHADEVAPPA.
  Studies and Research
  in Chemistry,
Manasagangotri,
University of Mysore,
Mysore-2 (India), *July* 27, 1965.

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ON A METHOD OF OBTAINING THE NON-ASTRONOMICAL SEA-LEVEL

A COMMON method for obtaining the residual sea-level from the observed tide data after eliminating the astronomical influences is to use the mean of 24 observations taken at mean solar hour intervals or alternatively to use 25 hourly observations. The former eliminates the contribution from the solar constituents and the lunar constituents considerably affect the results. The 25-hour method filters out practically the lunar constituents but it has an appreciable solar error.

Doodson[1] suggested a method using a 39-hour weighted average instead of that of 24 or 25-hour average. This method of averaging is developed by a combination of a number of filters each of which greatly weakens the contribution of one or more of the principal tidal constituents. Groves[2] while working on numerical filters for eliminating the tidal constituents arrived at several filters, the 39-hour compound filter suggested by Doodson being one of them.

While working with the tide data of Indian Ports the authors devised a simple method of eliminating the astronomical influences by obtaining the 25-hour average first and then subjecting the residual curve of sea-level to a 24-hour average. The original tide curve as well as the residual sea-level curve (after successive 25 and 24-hour averaging) are shown in Fig. 1. It has been found that the
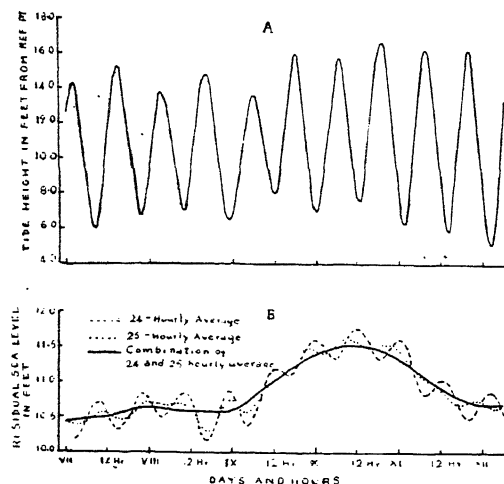

FIG. 1

residual curve is free from the small period oscillations caused by astronomical influences.

The meteorological or non-periodical effects on sea-level may be conveniently studied with the help of such a residual sea-level curve.

Indian Ocean Physical   V. V. R. VARADACHARI.
  Oceanographic Centre   G. SUBBA RAJU.
of Indian Ocean Expedition
  (C.S.I.R.),
Ernakulam-1, *June* 10, 1965.

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A NEW SYNTHESIS OF DIHYDRO ALLOEVODIONOL AND ITS METHYL ETHER

ALLOEVODIONOL (I),[1] its methyl ether (II)[2,3] and franklinone (III)[4] are related compounds occurring in Australian plants. The constitutions of the first two are well established. They are obviously derived from phloracetophenone by condensation with an isoprene unit. The constitution of franklinone has been unsettled till recently as to whether it had a linear structure (III) or the angular structure (IV). But the former was preferred as it will arise by the condensation of a second isoprene unit with alloevodionol.

I R = H
II R = CH₃   III   IV
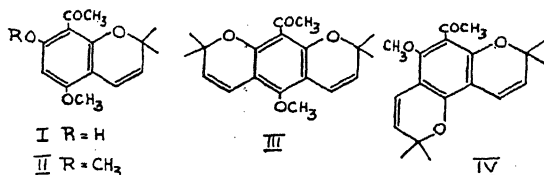
It was the purpose of our investigation to settle the final structure of franklinone by synthesis. As intermediate stages the preparation of dihydro-o-methyl alloevodionol (VII) and dihydro alloevodionol (VIII) has been attempted. The condensation of phloracetophenone dimethyl ether (V) with γ, γ-dimethylallyl bromide (VI) proceeded smoothly in the presence of zinc chloride to give a fairly

good yield (30%) of dihydro-o-methyl alloevodionol (m.p. 80–81°). This is a satisfactory alternative method, since the earlier method[5] *via* the chromanone involves many more stages. Partial demethylation of VII by means of aluminium chloride in ether affected the 7-methoxyl and gave a high yield of dihydro alloevodionol (m.p. 78°). Thus the present synthesis is a substantial improvement over the older method of Backhouse and Robertson.[5]
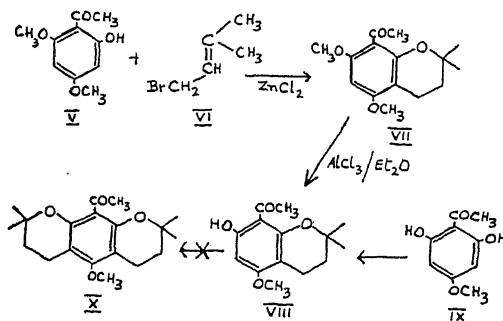
Our next object was to prepare tetrahydro franklinone (X) using dihydro alloevodionol and subjecting it to further condensation with γ, γ-dimethylallyl bromide, but this was unsuccessful. As an alternative approach a direct condensation of phloracetophenone-4-methyl ether (IX)[6] with excess of γ, γ-dimethylallyl bromide employing longer reaction time was attempted, but this yielded only dihydro alloevodionol. Obviously this molecule is not sufficiently active to undergo further condensation and the inactivity could be attributed to the presence of the methoxyl group. Unmethylated phloracetophenone molecule itself which is also more readily available was expected therefore to serve the purpose satisfactorily. At this stage of our investigation this scheme for the synthesis of tetrahydro franklinone, which also established its structure conclusively as III, was reported by Brown *et al.*[7] and hence the present work was given up.

Department of Chemistry,   D. ADINARAYANA.*
University of Delhi,   T. R. SESHADRI.
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CONDENSATION OF TOLYLENE-2 : 4-DIAMINE WITH BENZOIN

SYNTHESIS of 2 : 3-diphenyl indole derivatives by condensation of aromatic primary amines with benzoin has widely been studied,[1-6] though its application for the preparation of amino indoles is very limited.[7,8] We had occasion to study the reaction between tolylene-2 : 4-diamine and benzoin during the course of our attempts to synthesise amino indoles as potential intermediates for plant growth substances.

Equimolecular amounts of the diamine and benzoin were refluxed in xylene medium for 1·5 hours, with 1/8 molar proportion of p-toluene sulphonic acid monohydrate as catalyst, when a high melting crystalline solid separated out. This solid has been found to be insoluble in organic solvents, contained sulphur and could be converted into the soluble sulphur-free base by treatment with sodium bicarbonate. The presence of a primary amino group in the base is indicated by the ready formation of a phthalamic acid derivative and also I.R. spectrum. The absence of oxygen function is evident from analytical values and I.R. data. On analogy with earlier work,[8] it has been assigned 2, 3-diphenyl-5-methyl-6-amino indole structure (I).

The xylene filtrate, by application of thin layer chromatography on unfixed alumina, could be resolved into four crystalline compounds. The first compound is found to be identical with the sample isolated from the xylene insoluble product. I.R. data and formation of phthalamic acid derivative showed the presence of a free amino group in the second substance, while the ready formation of a 2 : 4-dinitrophenylhydrazone derivative and carbonyl absorption in I.R. spectrum indicated the presence of a >C=O group as well. It has been assigned tentatively structure (II), which corresponds to the open-chain intermediate of the amino indole (I). These two compounds (I) and (II) have resulted from the reaction of diamine and benzoin in 1 : 1 proportion.

The third compound contained a carbonyl group as indicated by the I.R. spectrum, although no crystalline derivative could be obtained with 2 : 4-dinitrophenylhydrazine. The

absence of a free primary amino group is evident from I.R. and also from the fact that no phthalamic acid derivative could be obtained. Analytical values indicated that it was formed from the reaction between one mole of diamine and two moles of benzoin. It has tentatively been assigned the structure (III).

The fourth substance, which is free from any oxygen function and primary amino group, has been found to be identical with the dipyrrolo benzene derivative reported earlier in literature.[9] Compound (III), with the same catalyst, could successfully be converted to (IV), which further supports the structure assigned to the former.

Full details will be published elsewhere.

(I)   (II)

(III)   (IV)
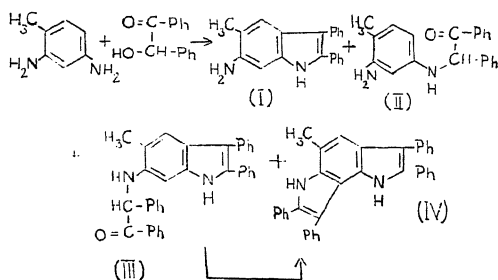
The authors are thankful to Prof. N. V. Subba Rao for his keen interest in this work and helpful discussions. One of the authors (K. S. R.) is grateful to the C.S.I.R. for the award of a Junior Research Fellowship.

Dept. of Chemistry,   K. Sudarsana Rao.
Osmania University,   C. V. Ratnam.
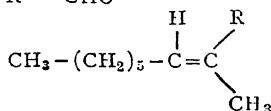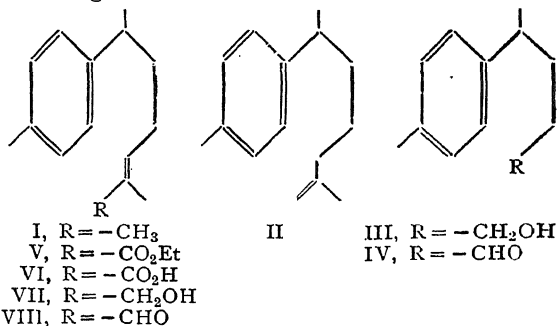Hyderabad-7 (A.P.), *May 3, 1965.*

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SYNTHESIS OF (±) α-CURCUMENE AND RELATED COMPOUNDS *

Recently we have established the absolute configuration of (+) *ar*-turmerone,[1] a ketone related to α-curcumene (I and II). We have also shown[2] that (−) α-curcumene investigated by Simonsen *et al.*[3] has the R-configuration.[4]

Oxidation of (±) 4-p-tolyl-1-pentanol[5] (III) with chromium trioxide-pyridine reagent[6] at room temperature (15–20°) furnished a mixture of starting material and the corresponding (±) aldehyde (IV). The (±) aldehyde was characterised as semicarbazone, m.p. 90–92° and 2, 4-dinitrophenyl hydrazone, m.p. 102–04° (Found: N, 15·38; $C_{18}H_{20}O_4N_4$ requires: N, 15·72%). Refluxing the aldehyde (IV) in benzene solution with isopropylidine triphenyl phosphorane[7] furnished (±) α-curcumene (I) identified by comparison of its retention time on VPC column with that of an authentic sample of α-curcumene.[2] (±) α-Curcumene, synthesised by this method, showed no absorption at 890 cm.$^{-1}$ In other respects its IR spectrum was in good agreement with that of an authentic sample,[2,8] known to be a mixture of (I) and (II). The NMR spectrum of the α-curcumene (I) is also in good agreement with the assigned structure.

I, R = −CH₃
V, R = −CO₂Et
VI, R = −CO₂H
VII, R = −CH₂OH
VIII, R = −CHO

II

III, R = −CH₂OH
IV, R = −CHO

$$CH_3-(CH_2)_5-C=C\begin{matrix}H & R\\ & CH_3\end{matrix}$$

IX, R = −CO₂CH₃
X, R = −CO₂H
XI, R = −CH₂OH
XII, R = −CHO

The (±) aldehyde (IV) on condensation with (α-carboethoxy-ethyledene)-triphenyl phosphorane furnished the (±) ester (V) (IR bands at 1710, 1639, 1515 and 820 cm.$^{-1}$). The structure assigned to (V) (cis-relationship of vinyl proton and CO₂Et) is based on previous work with this Wittig reagent.[9] Saponification of (±) ester (V) furnished the (±) acid (VI) characterised as S-benzyl isothiouronium salt, m.p. 128–30°. Since nuciferal (VIII) occurs in nature,[10] the corresponding acid (VI) may be expected to occur in nature. We are investigating the conversion of ester (V) to nuciferol (VII) and nuciferal (VIII).†

In connection with this investigation we have converted heptaldehyde to ester (IX) by reaction with (α-carboethoxy ethyledene) triphenyl phosphorane‡ (Prominent IR bands at 2890,

1715 and 1645 cm.$^{-1}$; VPC single peak. NMR signal at 3·35 τ due to vinyl proton *cis* to CO_2CH_3; Found: C, 71·3; H, 10·95. $C_{11}H_{20}O_2$ requires: C, 71·69; H, 10·94%). Saponification of ester (IX) furnished the acid (X) characterised as S-benzylisothiouronium salt, m.p. 131–33°. Reformatsky reaction of heptaldehyde with ethyl α-bromopropionate and subsequent dehydration‡ of the β-hydroxy ester with phosphorous oxychloride and pyridine-benzene mixture[11] furnished the ester (IX) identical with a specimen prepared through Wittig reaction. Lithium aluminium hydride reduction of ester (IX) furnished the alcohol (XI). (Prominent IR bands at 3344, 2865, 1449 and 1010 cm.$^{-1}$ VPC single peak, NMR signal at 4·65 τ due to vinyl proton *cis* to CH_2OH; Found: C, 76·74; H, 12·38. $C_{10}H_{20}O$ requires: C, 76·86; H, 12·9%).

The alcohol (XI) was oxidised to the aldehyde (XII) with chromium trioxide pyridine reagent[6] (Prominent IR bands at 2793, 2710, 1678 and 1631 cm.$^{-1}$; VPC single peak and λ_{max} at 229 mμ; ϵ 14,000). The aldehyde (XII) was characterised as semicarbazone, m.p. 155–56° Found: C, 62·94; H, 9·83; N, 19·42. $C_{11}H_{21}ON_3$ requires: C, 62·51; H, 10·02; N, 19·90%).

We thank Dr. S. C. Bhattacharyya for his interest in this investigation.

National Chemical Laboratory,   V. K. HONWAD.
Poona-8, *June* 21, 1965.   A. S. RAO.

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* Communication No. 784 from the N.C.I., Poona-8, TERPENOIDS—LXXII.

† When we were writing this paper, a preliminary communication,[12] giving the synthesis of (±) transnuciferol, has come to our notice.

‡ Followed by saponification and esterification with diagomethane.

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ABOUT SOURCE ROCKS*

PETROLEUM geologists have already established that *"with the increase of the quantity of organic matter in the rocks, the chloroform bitumen content of the organic matter regularly decreases"*. S. G. Neruchev (1962) showed that in the province of Pre-Caucasus (U.S.S.R.) the above-cited regularity holds good both for the Mesozoic and Paleogene-Neogene rocks.

As a result of careful study of the existing data on the geochemical analysis of the sediments of Pre-Caucasus, a very interesting regularity in nature has been found by the author. According to this regularity, *"with the increase of oil fraction in the chloroform bitumen, the chloroform bitumen content of the organic matter regularly decreases"*. This regularity is illustrated in Fig. 1.
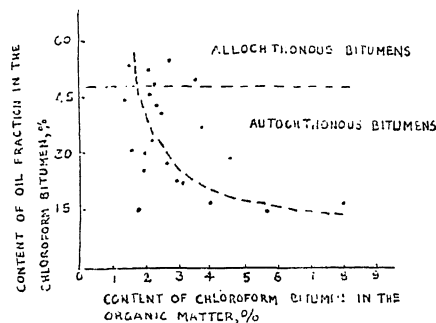
FIG. 1. Graph showing relationship between the oil-fraction content in the chloroform bitumen and the chloroform bitumen content in the organic matter of the Mesozoic, Paleogene and Neogene terrigenous rocks of Pre-Caucasus, U.S.S.R.

In the present work mainly chloroform bitumen has been taken into account. But, wherever available, and possible, data of other bitumen (spirit-benzol, etc.) contents were also studied and it was found that the qualitative results agree with that of the chloroform bitumen content.

In preparing the graph shown in Fig. 1, results of geochemical analyses of core samples from the wells of Pre-Caucasus, carried out by several individuals and research organisations of U.S.S.R., were used. Each observation point shown in the graph represents mean values of nearly 20 samples of shales, claystones and clays from a particular stratigraphic horizon in a particular area. The curve drawn in the graph shows a tendency of decrease in the chloroform bitumen content of the organic matter with a regular increase in the oil fraction content of the chloroform bitumen. The boundary drawn between the autochthonous and

allochthonous bitumens is purely an arbitrary one and only indicates the possibility of partial enrichment of autochthonous bitumens with allochthonous oil fractions.

The discovered regularity, which should find universal application, has both theoretical and practical importance. Evidently, the mother and source rock properties of any sediment should be judged mainly on the basis of oil fraction content in the chloroform bitumen and not only on the basis of chloroform bitumen content in the organic matter as was being done so far. A greater quantity of oil fraction in the chloroform bitumen, together with comparatively smaller quantity of chloroform bitumen in the organic matter, serves as a positive criterion for considering the sediments as better source rocks. However, it is always essential to take into account other relevant factors as well, especially the total quantity of the organic matter initially deposited with the sediments.

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AN UNFINISHED ? NEOLITHIC HAMMER-HEAD FROM KASHMIR

WHILE engaged on palæontological investigations in the Kashmir Himalaya, the hammer-head described here was found in the bed of the Kothiar Nallah.

The hammer-head is flattened, truncated and oval in outline along the longer axis, and rectangular with rounded angles on the sides. It is pierced centrally by a circular hole meant for accommodating a handle.

The specimen was apparently not a finished hammer-head because there are clear indications of well-defined lines along which it was obviously intended to trim it further (Figs. 1 and 2). The distance of these lines from the circumference of the hole varies from 18 mm. to 21 mm.

The dimensions of the hammer-head are: length 90 mm., breadth 50 mm., thickness 45 mm., diameter of shaft hole 16 mm.
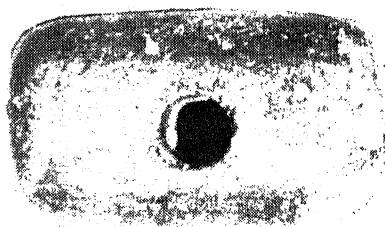
FIG. 1. Shaft-hole view of unfinished hammer-head showing trim lines.
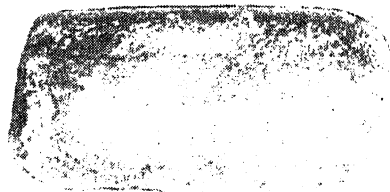
FIG. 2. Lateral aspect of hammer-head showing trim line (continued from shaft-hole view).

The hammer is made out of Panjal Trap, which is widely exposed in this area and thus occurs commonly as boulders in the stream which drains it.

The specimen may be provisionally assigned to the late Neolithic.

Geology Department,   M. R. SAHNI.
Panjab University,   V. J. GUPTA.
Chandigarh, *August* 1, 1964.

PRELIMINARY CYTOGENETICAL STUDIES IN *PSIDIUM CHINENSE*

Psidium chinense belongs to the family Myrtaceæ.[1] It is commonly known as 'Chinese guava' perhaps due to the small size of its leaves and fruits compared to those of *P. guyajva* Linn. A few plants of *P. chinense* have been found thriving in Allahabad. A search of literature shows that no cytological work has been so far done on this species.

Preliminary meiotic studies have revealed its haploid number to be 11 (Fig. 1).
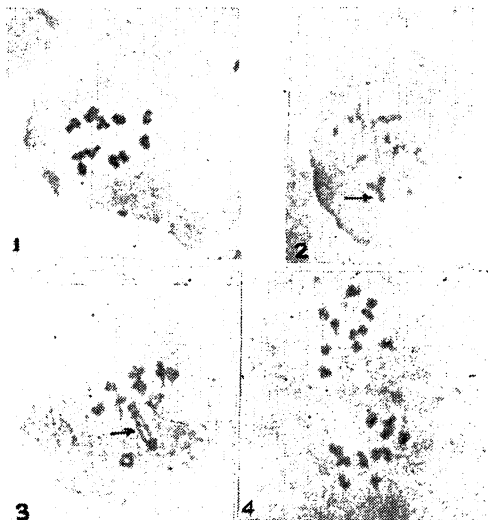
FIGS. 1–4. Meiotic chromosomes of *Psidium chinense*. Figs. 1–3. Metaphase-I. Fig. 1 Showing 11 bivalents. Fig. 2. One Y-shaped trivalent. Fig. 3. One quadrivalent and nine bivalents. Fig. 4. Anaphase-I showing 11 chromosomes on each pole.

P. chinense though a diploid shows several types of meiotic irregularities. At metaphase-I there may be all bivalents though occurrence of univalents, trivalents and quadrivalent have also been a common feature. It is perhaps the first record of regular association of more than two chromosomes in a diploid species of *Psidium*. Figure 3 shows a quadrivalent with nine bivalents. A single case of Y-shaped association of three chromosomes is another notable feature (Fig. 2). Anaphase-I displayed considerable irregularities owing to the presence of various associations of chromosomes. Dicentric bridges without fragments and laggards are commonly observed. Equal disjunction at anaphase-I nevertheless has been observed in many pollen mother cells (Fig. 4). Multivalents at metaphase-I reveal *Psidium chinense* to be a structural hybrid. Pollen fertility is about 55·3%.

The authors wish to express their thanks to the University Grants Commission for financial assistance and to Prof. R. N. Tandon for providing laboratory facilities.

Cytogenetics Laboratory,   S. P. NAITHANI.
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A FLORAL MUTANT IN PEA
(*PISUM SATIVUM*)

IN the course of investigation by the authors on production of useful mutations in crop plants by using radioisotopes, a new floral mutant in pea (*Pisum sativum,* var. N.P. 29) was observed to occur in the R_2 previously treated with a dose of $5 \cdot 0 \times 10^{12}$ np/cm.^{2} of pile neutrons. The mutant, grown from the seeds pretreated as above with pile neutrons, showed some flowers which were open and distorted. A closer examination revealed that the mutant had one normal and one abnormal flower among the two borne on each axil. The abnormal flower always appeared later to the normal one. In some cases this condition became extreme in the sense that in place of the abnormal flower there was only a rudimentary structure left or only the pedicel was seen. An open condition of flowers as found in our mutant has also been reported by Wellensiek[1] in the spoon-leaf mutant. However, the present mutant differs from the other in that such flowers are found in the fasciated-stem mutant ; also there is the tendency for such flowers to show changed numbers of sepals and petals, transformation of some of the stamens, and altered condition of carpel. Among such abnormal flowers sepaloidy and petaloidy were of frequent occurrence. Sepals and petals in some cases were wiry while in others a fusion of three or four of them produced a flap-like structure. Under these circumstances the sepals and petals were represented by numbers varying from 2–6 and 2–7 respectively.

In the case of androecium also the diadulphus condition was extremely changed. The number of stamens present in these flowers varied from 2 to 13. The filament in many cases showed various degrees of transformation, *e.g.,* in a few cases the staminal column while open had one of its parts modified into a petal-like structure bearing the anther in almost the middle of it. Also in this population of abnormal flowers 50% are staminate. In addition to the above-mentioned facts, the number of carpels was also varying from being unicarpellate to multicarpellate and apocarpous. The multicarpellate apocarpous condition is found in flowers which are completely female sterile though they had 90% pollen stainability. The fertility of the unicarpellate flowers was about 2%.

In conclusion the importance of the presence of unicarpellate functional open flowers for varietal maintenance in this crop is obvious. Apart from the significance of such mutants in breeding work, these facts may throw some

light on the origin of the genera and species in the family Papilionaceæ.

Our thanks are due to Dr. K. C. Bora of Atomic Energy Establishment, Trombay, Bombay, for kindly treating the seeds. We are also thankful to Shri T. C. Kala, Director of Agriculture, Rajasthan, Jaipur, for giving us facilities.

Section of Economic Botany,   R. P. CHANDOLA.
Govt. Agri. Res. Farm,   M. P. BHATNAGAR.
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ON THE IDENTITY OF *PORIA* FOUND IN ASSOCIATION WITH "BRANCH-CANKER" OF TEA IN NORTH-EAST INDIA

TUNSTALL,[1] Tunstall and Sarmah[2] and Sarmah[3] attributed the cause of branch-canker in tea in North-East India to the secondary wound parasite *Poria hypobrunnea* Petch.

Since Petch[4] described the above organism as a root parasite of tea, rubber and *Tephrosia candida* in Ceylon, the writer made a restudy of the identity of the fungus occurring in North-East India.

The fungus forms applanate fructifications on the underside of the branches, the context of the fructifications is reddish-brown and the spores are ovoid to globose, 5–7 × 4–6 μ, the hyphæ are rarely septate, thin to thick-walled, 2·5–4 μ in diameter. The fungus agrees very closely with *Poria punctata* (Fr.) Karst. It differs from the usual form in having setæ; these are rather few and somewhat variable and not so constant as to eliminate *P. punctata* which usually lacks setæ.

Poria hypobrunnea Petch, on the other hand, has dark purple context which is soft, felty, the hyphæ mostly solid and non-septate, some marginal hyphæ being thin-walled and septate. 3–6 μ in diameter, pore surface greyish-purple and according to Lowe[5] this fungus is most probably *Poria vincta* (Berk.) Cooke.

It is, therefore, concluded that *Poria* which is one of the fungi associated with branch-canker of tea in North-East India (Agnihothrudu[6]) is not *P. hypobrunnea* Petch but *P. punctata* (Fr.) Karst.

I am grateful to Rallis India Ltd. for permission to publish this paper, to Dr. J. L. Lowe, Research Professor of Plant Pathology, Syracuse University, New York, and Mrs. Frances F. Lombard of the Forest Disease Laboratory, USDA, for confirming the identity of the fungus.

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ON THE FOLIAR SCLEREIDS OF *AEGIALITIS ROTUNDIFOLIA* ROX B.

SOLEREDER (1908) has regarded the presence of sclereids in the mesophyll tissue of species of *Aegialitis* as a character of diagnostic value. Information on sclereid pattern can be utilised for evaluating the systematic value either for singling out a species or a group of species within a genus (Foster, 1945; Rao, 1957). In the present note, the form, structure and distribution of sclereids in the mature leaf of *Aegialitis rotundifolia* Roxb. are described. Materials were collected from Sundribans, West Bengal, during January 1965.

In *A. rotundifolia*, sclereids occur in the parenchymatous tissues of both the petiole and the lamina. They are of the diffuse, polymorphic type, dispersed more or less uniformly within the vein-islets in the lamina. In the dilated or winged petiole, the sclereids are abundantly present along the midrib and few in number in the flaps. They differ from one another in shape and size. Their disposition in the lamina is suggestive of a 'loose tissue' with interception of parenchymatous cells.

Foliar sclereids in *A. rotundifolia* can be grouped into two categories and intergrading forms are also frequently met with. These sclereids are fusiform to asymmetrical with a tendency to dichotomise (Figs. 2-7). Fusiform sclereids are encountered mostly on the adaxial side of the lamina whereas in the abaxial side they are abundant and present a bizarre of asymmetrical types with radiating arms (Fig. 1).

Petiolar sclereids are irregular cell forms with short radiating branches from the central body (Figs. 8-11, 13-14). They are scattered along the abaxial side of the dilated basal petiole, whereas in the midrib region, particularly in the lacunate parenchyma, they assume different shapes. Mostly they are beset with

radiating arms of varied lengths. Rarely fusiform sclereids with short spicule-like arms are present beneath the adaxial epidermal layer of the flaps of the petiole (Fig. 12). It is noticed that the small thick sclereids have more spicule-like short arms, when surrounded by compactly arranged parenchymatous cells. Structurally all these sclereids are thick-walled with a lumen, broad in the centre of the cell, gradually narrowing towards the arms. Pit canals are restricted to the radiating arms.
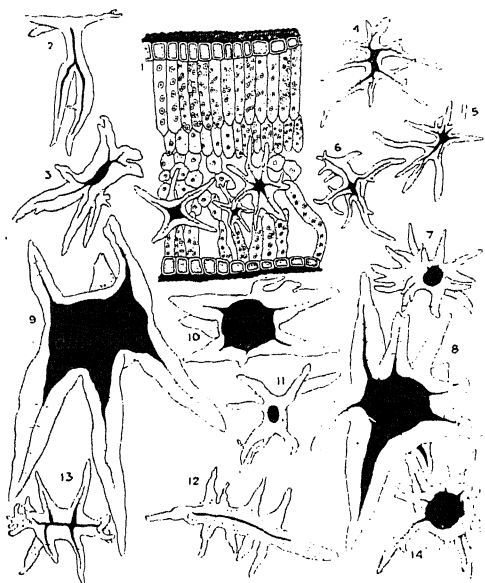
FIGS. 1-14. Foliar sclereids in *Aegialitis rotundifolia* Roxb. Fig. 1. Transection of mature lamina showing polymorphic sclereids, × 50. Figs. 2-7. Polymorphic laminar sclereids, × 50. Figs 8-11. Polymorphic petiolar sclereids, × 50. Fig. 12. Fusiform petiolar sclereid with spicules, × 50. Figs. 13-14. Polymorphic petiolar sclereids, × 50.

Studies by Foster (1946), Rao (1953), and Rao and Dakshni (1963) have emphasised the importance and systematic value of sclereids in many seed plants. *Aegialitis rotundifolia* Roxb. has been united with the Australian *A. annulata* R. Br. by de Candolle (1848). In the leaves of *A. annulata*, collected by Griffith (CAL. 271147) from Pegu and T. Anderson (CAL. 271148) from Mergui, both from Burma, available at the Central National Herbarium, Shibpore, it was observed that there are polymorphic sclereids closely resembling those of *A. rotundifolia*. Thus, from the standpoint of structure and topography of sclereids, there were no differences in these two species, thus confirming the view of de Candolle (*l.c.*).

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THE CHROMOSOMES OF *MORUS INDICA* LINN.

IT was reported recently that attempts were being made in Japan to breed polyploid varieties of mulberry since five among the ten best varieties under cultivation in 1954 were triploids resistant to cold and blight and were superior to the diploids in their nutritional value.[1]

The silkworm is rather fastidious in its food habit.[2] It is on record that the leaves of a Japanese graft variety were superior to that of a local bush in their nutritional value even though they had a lower mineral content.[3] In the above context a possible method of improvement of *Morus indica* is by artificial induction of polyploidy. To screen such induced polyploids, the availability of a simple technique is a prerequisite. The information available on the cytology of *Morus* species indicates that the chromosome numbers were estimated in roots mostly from sections.[4-7]

FIGS. 1 and 2. Metaphase. The two big chromosomes in the complement are indicated by arrows, × ca. 3,000.

The hæmatoxylin squash technique was devised originally for refractory plant material.[8] It has been employed not only for the study of chromosome numbers but also in attempts to elucidate chromosome structure.[9,10] Its recent adaptation for a study of the chromosomes of silkworms[11] suggested an exploration

of its utility for an elucidation of the chromosome number of *Morus indica.*

The seeds are small in size and take a long time to germinate on moist filter-paper in a petri dish. Therefore, they were allowed to sprout in running tap-water while tied up in a piece of cloth and were then grown in moist sand at 28° C. for 48 hours. To obtain a satisfactory scattering of the chromosomes, the seedlings were exposed to a saturated solution of α-bromonaphthalene either for 24 hours at 8–10° C. or for four hours at 28° C. The root-tips were then fixed in acetic alcohol (1 : 3) for 24-48 hours, hydrolysed in N HCl at 60° C. for 8–10 minutes, mordanted in 4% ferric ammonium sulphate for 20 minutes, stained in a 0·5% solution of hæmatoxylin for 30 minutes and then squashed in a drop of 45% acetic acid.

The photographs presented confirm the chromosome number of *Morus indica* as $2n = 28$. The mitotic complement contained only a pair of distinctly large chromosomes (arrows in Figs. 1-2) referred to variously as "alpha" and "beta" and as "allosomes"[12] and whose role in sex determination has been debated.[13]

Grateful acknowledgment is made to the Council of Scientific and Industrial Research, New Delhi, and the Indian Institute of Science, Bangalore, for their encouragement, to Drs. J. V. Bhat and M. B. Shyamala for the gift of the seeds, and to Dr. H. Chikushi of the Kyushu University, Fukuoka, Japan, for translations and microfilm copies of some of the papers.

Saraswathy Royan-Subramaniam.
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STUDIES ON BOMBAY RATS
A Modified Technique for Flea Indices

Since the report of the Advisory Committee on Plague,[14] flea indices are taken now and then to assess the density of fleas in a particular locality for epidemiological studies. In the original method advocated, the traps that had the rats were covered by bags and brought to a central place. Here, these traps were put in an airtight tin and the contents killed by chloroform or ether. This resulted in the recovery of dead rats and fleas. The latter were identified and pro-rata index fixed per rat.

From previous studies (see references) it became clear that an index should be taken on a specific basis so that one knows exactly the kind and number of fleas from a specific rat of a particular sex. Secondly, live undamaged fleas may be desirable for identification, pooling or for experimentation. In recent experiments at Bombay we had laid out traps with a thin layer of sand below them. The traps were collected the following morning in covers, and the sand below all traps was brought separately. It was noticed that this sand contained live fleas, even though in many cases there was no rat in that trap. This indicates that rats before entering a trap may be going about and releasing the fleas, some of which were collected at the base of the trap in the sand. For a correct assessment of flea indices, this factor should be taken into account and the present studies were accordingly undertaken.

A method has been developed here for trial for the last five years. In this the wonder traps are laid for the collection of rats in the evening. Next day workers go to the spot before sunrise. They cover the opening of the rat exit of the trap with a plastic bag, 12 inches long and 6 inches in diameter. The rat rushes through the exit as soon as it is opened and goes into the bag. Once inside the bag, it is either strangulated from outside or smashed by a pair of tongs. The exit is closed and the bag with the dead rat is removed and kept separately. Rats one by one are thus collected in plastic bags and these bags are brought to the laboratory. After the death of the rat, the fleas and other ectoparasites come out on the inside of the bags. These are then sucked out in a tube and identified or used later for pooling or experimentation. The pro-rata flea indices are then worked out.

The work was done in Bombay, Buldhana and recently in the field for one month in the North

Arcot District of Madras. Table I shows the collection of fleas by plastic bags for one

FIG. 1. Showing a rat just come into the plastic bag through the exit door of the wonder trap.

FIG. 2. Plastic bags with individual dead rats brought for examination. One rat *Tatera indica* being held by tail after removal from the bag.

TABLE I

Summary of the total of the monthly data of the species of rats trapped and species of fleas recovered by plastic bag technique at Bombay Port Trust in 1962

Total rats	Total fleas	Rats	Xc	Xa	Rats	Xc	Xa
			Rr (B)			Rr (W)	
2770	1667	982	627 92%	48 8%	361	211	nil

Total rats	Total fleas	Rats	Xc	Xa	Rats	Xc	Xa
			Bb			Rn	
2770	1667	979	141 22%	485 78%	317	162 90%	18 10%

Rr (B)—*Rattus rattus wroughtoni*, Rr (W)—*Rattus rattus rufescens*; Bb—*Bandicota bengalensis*; Rn—*Rattus norvegicus*. Xc—*Xenopsylla cheopis*; Xa—*Xenopsylla astia*.

year at the port trust area. This kind of species-wise index cannot be obtained by the

covered bag. Table II shows the recovery of fleas and indices by the three methods.

TABLE II

Indices taken by plastic bag, cover bag and spot brushing techniques

Days	Traps laid	Traps with rats	Total rats trapped	Fleas In sand	On rat	On cover	Total	Flea index
				Plastic Bag				
12	350	56	85	83	327	..	410	4·8
				Cover Bag				
12	350	60	94	19	328	144	491	5·14
				Spot Brushing				
7	175	25	39	29	79	..	108	2·9
	875	141	218	131	724	144	1009	4·6

It is a well-known fact that *Rattus rattus* has become resistant to Plague (Habbu[7]). In this species we have shown *Rattus rattus wroughtoni*, to be less resistant than *Rattus rattus rufescens* (I.C.M.R. Technical Report[8]). B. *bengalensis* still shows a marked amount of susceptibility to plague (Deoras[2]). X. *cheopis* is known to be a better transmitter of plague. It is therefore very essential if one knows the susceptibility of different fleas to different rats to give a clear picture of what is going on in Nature from the plague epidemeological point of view.

From Table I it is evident that these data on fleas and specific rats clearly indicate that X. *cheopis* is more on R. *rattus* than on B. *bengalensis*. Further R. *rattus rufescens* has more fleas than R. *rattus wroughtoni*. These numbers are for fleas actually taken from the rat only. From Table II it will be seen that the index is higher in cover bags, where more fleas were recovered from the cover itself. One therefore does not know where these fleas came from, *i.e.*, from what rat in the trap. It may also be argued that these may be the floating fleas from rats that moved round the trap but did not enter it. In that case they do not account for the index as per rat numbers in the trap. Similarly one may notice that, though the number of fleas on the rat is more or less equal, *i.e.*, 327 and 328, the index is higher in the cover bag only because of the floating fleas in the covered bags.

Table III shows that fleas in sand do constitute numbers which are varying and which may be remaining on the trap in the absence of sand. Our present technique was given

TABLE III

Number of fleas recovered from sand kept below the traps at Worli

Technique employed	No. of days	No. of traps laid	Traps with rats	Total fleas in sand	Fleas in sand only (No rats trapped in these traps)					Fleas in sand under traps with rats				
					X. cheopis		*X. astia*		Total	*X. cheopis*		*X. astia*		Total
					Male	Female	Male	Female		Male	Female	Male	Female	
Plastic bag ..	12	350	56	104	6	14	..	1	21	15	61	2	5	83
Cover bag ..	10	300	48	18	3	9	..	..	12	4	2	..	..	6
Spot brushing ..	5	125	18	40	11	11	..	..	22	8	10	..	..	18
	..	775	122	162	20	34	..	1	55	27	73	2	5	107

an extensive trial in recent epidemeological studies in South India for more than a month. It saves time, gives a specific picture of different rats and different fleas separately, reduces expenses on covers, and enables the collection of live fleas.

We are thankful to the Indian Council of Medical Research for the financial assistance, to the Director of Public Health, Madras, to the Port Trust, Bombay, and the Municipal Corporation, Bombay, for facilities, and to Sarvashri Shah, Chaturvedi, Renapurkar and Prasad for co-operation, and to the authorities of this Institute for enabling us to conduct these studies.

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A NEW LEAF-SPOT DISEASE OF TOBACCO

A SERIOUS leaf-spot disease of *nicotiana tabacum* L. was noticed in and around Muzaffarpur during the year 1962. The disease was encountered in the subsequent years as well. The spots appeared in round to oval patches showing concentric zones. The lesions enlarged rapidly and in many cases the whole lamina was affected. The infected leaves first became pale yellow and then turned brown to dark brown. In order to establish pathogenicity, healthy leaves of tobacco were artificially inoculated with the isolations made from the diseased leaves. Symptoms similar to those found in nature appeared on artificial inoculations. The isolate was sent to Kew, where it was identified as *Curvularia verruculosa* Tandon and Bilgrami.

Morphological studies revealed that the conidiophores, which were found on both the surfaces of the leaves of the host, were light brown in colour, unbranched, often bent, lateral or terminal in position and markedly geniculate with a bunch of conidia towards the apical end. The conidiophores were $3 \cdot 16-5 \cdot 00 \mu$ broad. The conidia were brown in colour, with a rough and verruculose wall, curved, seldom straight and four-celled. The third cell from the base was bulged out and the basal cell was hyaline. The conidia measured $19 \cdot 50-27 \cdot 30 \mu \times 7 \cdot 60-11 \cdot 70 \mu$. Thus the morphological characters of the pathogen were in conformity with its monographic account which has recently been given by Tandon and Bilgrami (1962), who reported the fungus as a new species.

Our sincere thanks are due to Dr. Ellis of the Mycological Institute, Kew, for identification of the pathogen.

Department of Botany,   S. S. PRASAD.
Bihar University (L.S. College),   B. ACHARYA.
Muzaffarpur, *February*, 12, 1965.

1. Tandon, R. N. and Bilgrami, K. S., "A new pathogenic species of the genus *Curvularia*," *Curr. Sci.*, 1962, **31**, 254.

REVIEWS AND NOTICES OF BOOKS

Spectroscopy and Photochemistry of Uranyl Compounds. By Eugene Rabinowitch and R. Linn Belford. (Pergamon Press), 1964. Pp. x + 370. Price 80 *sh.* net.

In the fifties of the last century Sir George Stokes discovered that when a crystal of uranyl nitrate is illuminated with a beam of blue light (white light filtered through copper salt solution), the light emerging from the crystal exhibits a most remarkable spectrum consisting of nothing but bands arranged at regular intervals. Since then, the subject has been extensively investigated. A survey of this field right up to the present time is presented in this volume, which includes a bibliography of over 300 references to research on the interaction of uranyl ion with light. The survey is divided into five chapters: Spectroscopy of Uranyl Salts in the Solid State; Spectroscopy of Uranyl Compounds in Solution; Uranyl Fluorescence Intensity and Decay: Photochemistry of Uranyl Compounds; and Theory of Uranyl Ion Structure and Spectra. Each chapter contains an historically arranged narrative, with limited amounts of critical commentary and extensive summary of original literature on the subject, thus enabling the user to keep the survey up-to-date merely by adding notes on new work as it appears. The literature on spectra and photochemistry of uranyl compounds is vast; some of it is difficult to discover, and even when identified may not be readily available to all scientific libraries. This book, therefore, will be particularly useful; it places at the disposal of research workers the results of pertinent past work, permitting them to design and interpret their own experiments to better effect. The book will be of considerable value to both students and advanced workers and is warmly recommended.

C. V. R.

Dynamic Stability of Elastic Systems. By V. V. Bolotin. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. xii + 451. Price $ 12.95.

In this volume the reader is presented with a first-principles treatment of the important field of dynamic states of elastic systems. Professor Bolotin has given a systematic develop-

ment of the subject ranging from systems with one degree of freedom to those with several degrees of freedom. Both the linear and non-linear aspects of these systems are treated thoroughly and with refreshing insight. The mathematical concepts and techniques are introduced at the appropriate stages and then put directly to use.

The text contains material not easily accessible and includes Bolotin's original contributions to the field. The author himself has co-operated in clarifying many subtle points besides reviewing the entire book prior to its publication. The book should prove especially valuable to teachers of this subject as well as to theoreticians and practising technologists.

C. V. R.

Advances in Morphogenesis. Edited by M. Abercrombie and Jean Brachet. (Academic Press, New York and London), 1964.
Volume 3, Pp. xi + 408. Price $ 14.00.
Volume 4, Pp. ix + 287. Price $ 12.00.

Volume 3 of this series contains the following chapters: Mechanisms of Determination in the Development of Gastropods, by Chr. P. Raven; Non-Filamentous Aquatic Fungi, by Edward C. Cantino and James S. Lovett; Biochemical Studies on the Early Development of the Sea Urchin, by Alberto Monroy and Rachele Maggio; Biochemical Aspects of Animalization and Vegetalization in the Sea Urchin Embryo, by R. Lallier; The Blood of Chick Embryos: Quantitative Embryology at a Cellular Level, by Leo Lemez; The Role of Nucleic Acids and Sulphydryl Groups in Morphogenesis (Amphibian Egg Development, Regeneration in *Acetabularia*), by Jean Brachet; The Acrasina (continued from Vol. 2, pp. 109–182), by B. M. Shaffer; Cell Divisions, Duration of Interkinetic States and Differentiation in Early Stages of Embryonic Development, by T. A. Dettlaff; and The Morphogenetic Role of the Cortex of the Amphibian Egg, by Jean J. Pasteels.

Volume 4 of this series contains the following chapters: The Transplantation of Living Cell Nuclei, by J. B. Gurdon; Morphogenesis in *Micrasterias*, by H. Waris and P. Kallio; Problems in Corneal Morphogenesis, by Alfred J.

Coulombre; Regeneration in Lower Plants, by Luise Stange; Regeneration in Annelids, by Henriette Herlant-Meewis; and Biological Aspects of the Yolk of the Hen's Egg. **C. V. R.**

Adsorption and Collective Paramagnetism. By Pierce W. Selwood. (Academic Press, New York and London), 1962. Pp. ix + 189. Price $ 7.50.

This research monograph describes a novel method for studying molecular interactions on solid surfaces through measurements of magnetisation. Chief applications are to the mechanism of chemisorption, to heterogeneous catalysis, and to related surface phenomena, with certain implications concerning the magnetic properties of transition elements and their compounds. The titles of the ten articles contained in this book are as follows: 1. Chemistry of Solid-Vapor Interfaces; 2. Introduction to Magnetism; 3. Very Small Ferromagnetic Particles; 4. The Measurement of Saturation Magnetization; 5. Saturation Data; 6. The Measurement of Magnetization at Low H/T; 7. Magnetization-Volume Isotherms for Hydrogen; 8. Hydrogen Sulfide, Cyclohexane, Cyclohexene, and Benzene; 9. Ethane, Ethylene, and Acetylene; and 10. Carbon Dioxide, Carbon Monoxide, Oxygen, and Nitrogen. **C. V. R.**

Principles of the Theory of Solids. By J. M. Ziman. (Cambridge University Press), 1964. Pp. xiii + 360. Price $ 8.50.

This book presents, in simple terms, the elements of the theory of the physics of perfect crystalline solids, and is an exposition of the mathematical consequences of lattice periodicity. It is intended as a text-book for use in graduate courses on solid state physics, and is based on the author's experience in teaching such courses in England and the United States.

It is a straightforward account of the principles, rather than an exhaustive description of the various phenomena, and gives, in each case, a self-contained mathematical treatment of the simplest model that will demonstrate the principle under discussion. The author's aim is to enable the student to appreciate the conditions that are essential to the appearance of the phenomena at all, rather than to provide a full but complicated theoretical account of each one. The focus throughout is upon clarity of exposition.

The author assumes familiarity with the elementary descriptive facts about solids and with the elements of quantum mechanics as taught in undergraduate courses. **C. V. R.**

Chelating Agents and Metal Chelates. Edited by F. P. Dwyer and D. P. Mellor. (Academic Press, New York and London), 1964. Pp. xv + 530. Price $ 17.00.

This important treatise presents fundamental data on the structure and properties of metal chelates. The book contains the following ten chapters: 1. Historical Background and Fundamental Concepts, by D. P. Mellor; 2. The Nature of the Metal-Ligand Bond, by D. P. Craig and R. S. Nyholm; 3. Bidentate Chelates, by Clive M. Harris and Stanley E. Livingstone; 4. Design and Stereochemistry of Multidentate Chelating Agents, by Harold A. Goodwin; 5. Optical Phenomena in Metal Chelates, by A. M. Sargeson; 6. Oxidation-Reduction Potentials as Functions of Donor Atom and Ligand, by D. A. Buckingham and A. M. Sargeson; 7. Metal Chelates of Ethylenediaminetetraacetic Acid and Related Substances, by F. L. Garvan; 8. Enzyme-Metal Ion Activation and Catalytic Phenomena with Metal Complexes; by F. P. Dwyer; 9. Metal Chelates in Biological Systems, by A. Shulman and F. P. Dwyer; and 10. Physical and Co-ordination Chemistry of the Tetrapyrrole Pigments, by J. E. Falk and J. N. Phillips.

This work will be of great interest to chemists, biochemists, microbiologists, enzymologists, physiologists and medical and biological research workers. **C. V. R.**

Carbene Chemistry, Volume 1 of *Organic Chemistry.* Edited by Albert T. Blomquist. Author: Wolfgang Kirmse. (Academic Press, New York and London), 1964. Pp. viii + 302. Price $ 9.50.

This book provides the first comprehensive account of a new and rapidly expanding field of organic chemistry. It contains a complete and up-to-date survey of carbene reactions and their applications in synthesis. The eleven chapter headings in the book give an idea of the scope of the book, *viz.,* I. Introduction; II. Methylene; III. Alkyl- and Dialkylcarbenes; IV. Olefinic and Acetylenic Carbenes; V. Aryl- and Diarylcarbenes; VI. Carboalkoxycarbenes; VII. Ketocarbenes; VIII. Halocarbenes; IX. Carbenes Containing α-Hetero Atoms; X. Dicarbenes; XI. Excess Energy in Carbene Reactions, by H. M. Frey; and XII. The Spin States of Carbenes, by Peter P. Gaspar and George S. Hammond. **C. V. R.**

Annual Review of Biochemistry (Vol. 33). (Annual Reviews, Inc., 231, Grant Avenue, Palo Alto, California, U.S.A.), 1964. Pp. vii + 855. Price $ 9.00.

Volume 32 of this series was reviewed in the May 20, 1965, of *Current Science*.

The present volume comprises twenty-four chapters whose titles and their respective authors are as follows : 1. Prefatory Chapter, by Otto Warburg ; 2. Mechanisms of Certain Phosphotransferase Reactions, by J. P. Hummel and G. Kalnitsky ; 3. Polysaccharides, by D. H. Northcote ; 4. The Chemistry of Lipids, by Roscoe O. Brady and Eberhard G. Trans ; 5. Carbohydrate Metabolism, by Gilbert Ashwell ; 6. Lipid Metabolism, by P. Roy Vagelos ; 7. The Chemistry and Metabolism of Recently Isolated Amino-Acids, by L. Fowden ; 8. Genetic Coding for Protein Structure, by J. Claude Bennett and William J. Dreyer ; 9. Biochemical Aspects of Genetics : The Operon, by Bruce N. Ames and Robert G. Martin ; 10. Chemistry and Metabolic Action of Nonsteroid Hormones, by Robert Schwyzer ; 11. Vitarin and Coenzyme Function : Vitamin B_{12} and Folic Acid, by L. Jaenicke ; 12. Fat-Soluble Vitamins, by U. Gloor and O. Wiss ; 13. Metalloproteins, by Bo G. Malmstrom and J. B. Neilands ; 14. Immunochemistry, by Alfred Nisonoff and G. Jeanette Thorbecke ; 15. The Biochemistry of Muscle, by W. Wayne Kielley ; 16. Bioluminescence, by Milton J. Cormier and John R. Totter ; 17. Iron Metabolism, by Callie Mae Coons ; 18. Application of Nuclear Magnetic Resonance in Biochemistry, by Arthur Kowalsky and Mildred Cohn ; 19. Biochemistry of Cancer, by Harris Busch and Wesley C. Starbuck ; 20. Metabolism of Drugs and Toxic Substances, by Louis Shuster ; 21. The Chemistry of Peptides and Proteins, by C. H. W. Hirs ; 22. Amino-Acid Metabolism, by David M. Greenberg ; 23. Metabolism of Nucleic Acids, by Gerhard Schmidt ; and 24. Biological Oxidoreductions, by Lars Ernster and Chaun-pu-Lee.   C. V. R.

Atherosclerosis and Its Origin. Edited by Maurice Sandler and Geoffrey H. Bourne. (Academic Press, New York and London), 1963. Pp. xiii + 570. Price $ 22.00.

In this work it has been attempted to cover the field of atherosclerosis focusing on the human lesion, reverting to information from lower species when the information has not yet been obtained in man. Chapters on the histology, pathology, and metabolism of arterial tissue have been included. Believing as do the more sophisticated workers in the field today that there is no one cause of atherosclerosis, chapters have been included on the role of ground substance, hemodynamics, serum lipids, hormones, diet, and the arterial wall metabolism in the development of the lesion.   C. V. R.

Advances in Drug Research (Vol. I). Edited by H. J. Harper and Simmonds. (Academic Press, London and New York), 1964. Pp. x + 209. Price 50 sh.

This volume provides a medium for the presentation of significant current progress to chemists, biochemists and pharmacologists who are interested in the chemical and biological aspects of drugs. The series will provide comprehensive surveys, not only in established areas of drug research but also in the newer and sometimes relatively narrower, more exploratory areas.

The scope of the book is indicated by the four chapters whose titles and their respective authors are as follows : 1. Penicillins and Related Structures, by F. P. Doyle and J. H. C. Nayler ; 2. Physiological Transport of Drugs, by Lewis S. Schanker ; 3. Antitussives, by F. P. Doyle and M. D. Mehta ; and 4. Adrenergic Neurone Blocking Agents, by F. C. Copp.
                    V. S. R.

Physics. By W. E. Hazen and R. W. Pidd. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A.), 1965. Pp. 628. Size 24 cm. × 19 cm. Double column. Price $ 11.75.

This is an introductory text-book of physics, both classical and modern, and has been designed for a three semesters course to selected students in the college of engineering at the University of Michigan. A skip through the pages shows that the book is full of formulas, figures and problems. It can be used as a rapid refresher course to those who wish to teach physics at a university entrance level, or profitably read by students of allied disciplines desiring to have a good understanding of the basic ideas of physics.   A. S. G.

Selected Topics in Modern Chemistry. (Chapman and Hall Limited, 11 New Fetter Lane, London, EC 4.) Each volume about Pp. 120. Price 10 sh. 6 d.

Eight pocket books of this series of *Selected Topics in Modern Chemistry* issued in the first half of 1965 were reviewed in *Current Science*

of June 20, 1965 (Vol. 34, p. 388). We are glad to announce the following further titles that have come out in this series: The Chemistry of Some Life Processes, by V. H. Cheldelin and R. W. Newburgh; The Mole Concept in Chemistry, by W. F. Kieffer; The Nature and Chemistry of High Polymers, by K. F. O'Driscoll; Inorganic Complex Compounds, by R. K. Murmann; Colloid Chemistry, by M. J. Vold and R. D. Vold; Basic Concepts of Nuclear Chemistry, by R. T. Overman.

The authors are experts who have worked in the fields concerned and who desire to share their interest and the new knowledge obtained with others. Thus these pocket books are authoritative and written in clear and simple language at undergraduate chemistry level.   A. S. G.

Vitamin B$_{12}$. By E. Lester Smith. (*Methuen's Monographs on Biochemical Subjects*) (Methuen and Co. Ltd., London, and John Wiley and Sons, Inc., New York), 1965. Pp. 180. Price 25 *sh*.

The first edition of this popular monograph on Vitamin B$_{12}$ was published in 1960, followed by the second edition in 1963 which contained some minor revisions and a new chapter on the coenzyme forms. The importance of the coenzyme form of vitamin B$_{12}$ is now well recognized; in fact the coenzyme is the functional form in most, though not all, of the reactions mediated by vitamin B$_{12}$. In the light of these significant new developments, the third edition has been completely revised and reset, and the monograph still stands as the latest balanced review on the subject of vitamin B$_{12}$ and its coenzymes.   A. S. G.

Modern Organic Chemistry. By N. G. Clark. (Oxford University Press), 1964. Pp. 574. Price Rs. 28.00.

The book will serve as a good introduction to modern organic chemistry. In presenting the material the author does not deal in detail so much with individual compounds, but pictures the class of compounds as a whole and explains them in terms of the characteristics of the fundamental groups, their mutual influence, and their effects on adjacent portions of the molecule. This general but systematic approach makes the study of organic chemistry practical and

interesting. Emphasis has also been given to manufacturing processes and industrial applications wherever necessary.

The contents are divided into four parts, bulk of which are Part II of thirteen chapters on aliphatics, and Part III of six chapters on aromatics. Part I of four chapters deals with general concepts of structure, and stereochemistry. Part IV contains two chapters, first on experimental methods and the second on electronic theory. At the end of each chapter is given a set of original questions which add to the usefulness of the book.

The book can be recommended as a suitable text-book of organic chemistry for the 1st Year and Degree classes of Indian University.   A. S. [G.]

Books Received

Mathematical Theory of Electromagnetism. Bansi Lal. (Asia Publishing House, Civic Street, Ballard Estate, Bombay-1), Pp. xii + 510. Price Rs. 15·00.

Organic Chemistry—A Series of Monographs (Vol. 2)—*Bridged Aromatic Compounds.* B. H. Smith. (Academic Press, Inc., New York-1003), 1965. Pp. xi + 553. Price $ 12.

The Skin of the Earth. By A. Austin M[iller]. Methuen & Co., Ltd., London E.C. 4), Pp. ix + 189. Price 9 *sh*. 6 *d*.

Advances in Space Science and Technology. Edited by F. I. Ordway III (Vol. 7). (Academic Press, New York), 1965. Pp. xvii + . Price $ 15.00.

The Nature and Chemistry of High Polymers. By K. F. Odriscoll. (Chapman & Hall, London E.C. 4), 1965. Pp. ix + 111. Price 10 *sh*. 6 *d*.

Marine Microbial Ecology. By E. J. Ferguson Wood. (Chapman & Hall, London E.C.), 1965. Pp. xii + 243. Price 42 *sh*.

Statistical Analysis in Biology. By Kenneth Mather. (Methuen & Co., London E.C. 4), Pp. 267. Price 12 *sh*. 6 *d*.

The Ideas of Biology. By J. T. Bonner. (Methuen & Co., London E.C. 4), Pp. 239. Price 15 *sh*.

Optical Rotatory Dispersion and Circular Dichroism in Organic Chemistry. P. Crabbe. (Holden-Day, 728, Montgomery St., Sanfrancisco), 1965. Pp. xv + 369. Price $ 12.95.

THE NEW PHYSIOLOGY OF VISION

Chapter XXVI. Structural Colours

SIR C. V. RAMAN

THE studies of the visual synthesis of colour described in several of the preceding chapters were made with various materials exhibiting highly pronounced colours by reason of their ability to absorb certain well-defined regions in the spectrum while freely transmitting the rest. The reason for choosing them as the subject of study was, besides the availability of the materials, the possibility by making use of them of arriving at definite conclusions regarding colour and its relation to the spectral constitution of light. There are, however, numerous other ways in which colours can arise and be perceived. It is clearly desirable that such cases should also receive consideration in our survey of the origins of colour and its visual perception.

The Colours of Interference.—The colours of thin films are amongst the most familiar phenomena in physical optics and we naturally begin by considering their nature and origin. A very convenient way of producing them for the purpose of a detailed study is to put together two similar flat plates of glass, each about half a millimetre thick and two or three centimetres square in area. When pressed into contact after careful cleansing, they adhere in certain areas and are separated by an air-film in other areas. As seen by reflected light, the areas of adhesion appear quite black, while the other regions exhibit colour. It is often possible to get the plates adhering all along the outer edges, while the area within shows a sequence of interference colours appearing as a series of closed curves.

It is a significant fact of observation that the colour sequence in the fringes exhibited by air-films of progressively increasing thickness is the same irrespective of whether the fringes are straight or curved or irregular, irrespective of whether they are broad or narrow, and irrespective of whether they are equally or unequally or even randomly spaced. These facts become intelligible if it be recognised that the lines of colour follow the contours of luminosity in the field. The illumination at any point in the field of observation is determined by the thickness of the air-film at that point and its relation to the wavelength of the part of the spectrum which is visually the most effective. This is the yellow sector of the spectrum and its average wavelength may be taken as 580 mμ. Where the luminosity of the field as determined by the thickness of the air-film in relation to this wavelength is a maximum, the field would exhibit a yellow colour, and the rest of the spectrum would have but little chromatic effect. *Per contra,* it is in those parts of the field where the intensity due to the yellow sector is zero or small, that the other colours in the spectrum can manifest themselves most clearly.

The regions of zero intensity for light of wavelengths greater than that of yellow light and for light of wavelengths less than that of yellow light would evidently adjoin the regions of zero illumination for yellow light, but would be located on opposite sides of the same. Hence, in the regions where the light of such greater wavelength has a low intensity, the light of the smaller wavelengths would be dominant and determine the observed colour. *Vice-versa,* in the regions where the light of the smaller wavelengths has a low intensity, the light of the greater wavelengths would dominate and determine the observed colour.

The foregoing considerations are fully supported by the actual facts of observation. In particular, it is evident on inspection that the bands of colour follow the contours of minimum luminosity in the field and that the colours are most vivid in the regions adjoining them on either side. On the other hand, along the contours of maximum luminosity, the colour exhibited is yellow, while green and red appear respectively on the two sides of the lines of minimum luminosity.

The classic illustration of the colours of interference is the phenomenon described in detail by Newton and known by his name which is exhibited by an air-film between two polished surfaces of glass having different curvatures. The interferences appear as circular rings surrounding the point where the two surfaces are in actual contact, this appearing as a black spot. If the rings are formed between two surfaces of which the curvatures are not nearly the same, the area over which the interferences

are visible in white light would necessarily be limited and the successive rings would be close to each other. In such cases, it is found that though the rings can be seen quite clearly when the air-film is held at the usual distance of distinct vision from the eyes of the observer, no colours are visible, the pattern exhibiting only variations of brightness. Five or six rings can be counted, the contrast between the dark and bright rings falling off in the successive rings. To observe colours in such cases, it is necessary to examine the interference-pattern closely through a magnifier. The colour-sequence as described earlier can then be recognised.

The explanation of the remarkable facts stated above is not far to seek. Newton's rings exhibit the fluctuations of luminosity which arise from interference as observed in white light and the appearance of colour is only an incidental circumstance. The eye perceives only the fluctuations of brightness and does not perceive any differences in colour unless the regions in which the spectral characters of the light differ are widely enough separated for the eye to recognise them as distinct areas in the field.

The Colours of Rotary Dispersion.—Very interesting cases in which structural colours are observed present themselves when plane-polarised light traverses a crystal having a chiral structure. The best known example is that of quartz. The colours under reference are observed when a plate of this crystal cut perpendicular to its optic axis is set between two polaroids and a bright source of light is viewed through the combination. To observe the colours at their best, one should use a pair of polaroids which give a perfect extinction of light without perceptible colour when they are in the crossed position. The rotation of the plane of polarisation produced by the passage through the crystal is proportional to the thickness of the plate and depends on the wave-length of the light. Hence when a plate of any particular thickness is used, it is possible to extinguish any specified part of the spectrum by a suitable setting of the polaroids with respect to each other, while the rest of the spectrum is transmitted. As the position of the spectral band of extinction can be varied by rotating one of the polaroids, the spectral constitution of the emerging light is altered and its observed colour also changes. By using a set of quartz plates of different thicknesses,

the relation between the perceived colour of light and its spectral constitution can be studied in this manner in a great many different cases.

TABLE I
Rotation in degrees of arc for different wavelengths

Plate Thickness	400 mμ	450 mμ	500 mμ	550 mμ	600 mμ	650 mμ
0·46 mm.	23	18	14	12	10	9
0·68 ,,	34	27	21	17	14	12
0·84 ,,	42	33	26	21	18	15
0·96 ,,	48	38	30	24	20	17
3·00 ,,	150	117	93	75	63	54
5·00 ,,	250	195	155	125	105	90
6·00 ,,	300	234	186	150	126	108

In the present studies, seven plates of quartz of different thicknesses were used. Four of the plates had thicknesses which were fractions of a millimetre, while the three others had thicknesses of three, five and six millimetres respectively. These thicknesses and the optical rotations to which they give rise to for various wavelengths are shown in Table I. The figures were computed from Chandrasekhar's formula which is quite simple and represents the optical activity of quartz with great accuracy over the entire range of wavelengths.

When a plate of quartz is interposed between two crossed polaroids, there is a restoration of light which cannot be quenched by a rotation of one of the polaroids. It is however possible in the case of the quartz plates of the thicknesses listed in Table I to find a setting in which the light emerging through the combination has the minimum brightness. In these circumstances, the emerging light is found to exhibit a purple colour. A rotation of the polaroid away from this setting in one direction or the other results in a brightening of the field as well as a change of colour, this being different for the two directions. In one case, the field exhibits a blue colour and in the other case it becomes bright yellow. The magnitude of the rotation required for the change of colour from purple to blue or from purple to yellow increases with the thickness of the plate.

Transitional colours appear in the intermediate stages.

Spectroscopic examination of the light of purple colour emerging along the optic axis at the setting for minimum transmission reveals a dark band of extinction covering the yellow sector, the green and blue sectors being clearly visible on the one side and the red sector on the other side of the spectrum. A rotation of the polaroid away from that setting results in a displacement of the extinction band in the spectrum; it moves from the yellow to the green or from the yellow to the red respectively for a rotation in the two directions. Such spectral displacement results in an increased brightness of the transmitted light and also a change in its colour.

The magnitudes of the rotation for different wavelengths listed in Table I enable us to understand why the colour of the transmitted light is blue for some settings of the polaroids and yellow for other settings. The colour is determined by the luminosity of the blue and green sectors relatively to the yellow and red sectors in the spectrum of the transmitted light. The great difference in rotatory power at the two ends of the spectrum results in the short-wave end or the long-wave end becoming its dominant feature as determined by the setting of the polaroids. In the former case, the resultant sensation is blue, and in the latter it is yellow.

The difference in the optical rotation at the two ends of the visible spectrum is less than 180° for all the plates listed in Table I except the thickest for which it is slightly in excess of that value. Hence, only one extinction band can appear in the spectrum of the transmitted light and this would shift from one end of the spectrum to the other as one polaroid is rotated, finally passing out of the spectrum altogether. When the latter is the case, the transmitted light could, if at all, exhibit colour only by reason of the altered distribution of intensity in the spectrum which results from the presence of the second polaroid. The effects thus arising are scarcely noticeable in the case of the four thinnest plates. They are, however, observable in the case of the plates which are three or five millimetres thick, and are quite conspicuous in the case of the six-millimetre plate.

The Colours of the Sky and the Sea.—When white light traverses a transparent medium, its molecules scatter or diffuse the radiation and the light thus diffused when perceived by the observer is found to exhibit a blue colour. The explanation of this effect usually given is that the scattering power of the medium depends on the wavelength of the radiation traversing it. The proportion of the scattered to the incident light varies inversely as the fourth power of the wavelength and is thus much greater for the short-wave regions in the spectrum than for the long-wave part of it. This argument is clear enough from a physical standpoint; but it leaves the actual facts of the case, *viz.*, the perception of a blue colour, without any real explanation. The inadequacy of the argument becomes evident when an observer views the blue sky through a pocket spectroscope and compares it with the spectrum of a white cloud floating in the sky. In both cases, the entire solar spectrum is visible and in both cases the green, yellow and red sectors are much more luminous than the blue sector. The blue sky is much less bright than a white cloud; hence the spectrum in the latter case is the more brilliant. Scrutiny reveals that this difference in brightness is more evident for the green, yellow and red sectors than for the blue sector. In other words, the blue sector gains relatively to the green, yellow and red sectors in the spectrum of the blue sky. Nevertheless, these sectors continue to be more luminous than the blue sector. Why then do we see the sky as blue while the cloud appears white?

The answer to the paradox stated above is furnished by the phenomena of the superposition and masking of colours which formed the subject of an earlier chapter. The sensation of white light is the result of the superposition of radiations appearing in the two parts of the spectrum of which the wavelengths lie respectively in the ranges from 400 mμ to 500 mμ and from 500 mμ to 700 mμ. The superposition of radiations appearing only in the first range results in the chromatic sensation which we call blue. The superposition of the radiations appearing only in the second gives the chromatic sensation which we call yellow. When superposed in an appropriate ratio, these two sensations merge and give rise to an achromatic sensation. But if one is present in excess, either sensation can mask the other and prevent its being perceived. The presence of the sensation which is suppressed however makes itself felt as a dilution or weakening of the chromatic sensation which survives.

In diverse fields of experience, the foregoing ideas find confirmation. For example, many

flowers contain the carotenoid pigments in their petals and exhibit a yellow colour. But the intensity of the colour varies from the palest cream to a rich golden hue as determined by the strength of absorption of the blue sector by the pigments. The familiar variations in the colour of the sky from the palest blue to the deepest azure are likewise explicable in terms of the spectral nature of the scattered light in various circumstances. As sunlight is progressively denuded of the components of shorter wavelength in its spectrum by traversing long paths in the atmosphere, a stage is reached when an observer would perceive its colour as yellow. Thus, the colours of the twilight sky can be explained on the same basis as the complementary phenomenon of the blue colour normally exhibited by the sky.

The molecular diffusion of light also plays a highly important role in producing the blue colour exhibited by the water in deep lakes and by oceanic waters when the turbidity which results in a lack of transparency is at a sufficiently low level. In such cases, it is noticed that the blue colour is much deeper than the colour of the sky. The reason for this difference is to be found in the absorption of sunlight when it traverses long columns of water. This absorption is weak but selective, being confined to the long-wave region in the spectrum. This part of the spectrum would be weakened when the incident light traverses the medium and again after diffusion returns to outer space. As a result of these processes, there would be a large preponderance of the short-wave part of the spectrum in the diffused light emerging from the medium. The highly pronounced blue colour actually exhibited by such waters thus finds a natural explanation.

ON THE ABSORPTION AND FLUORESCENCE SPECTRA OF PRASEODYMIUM DOPED KCl SINGLE CRYSTAL

R. K. ASUNDI AND R. C. NAIK

Spectroscopy Division, Atomic Energy Establishment, Trombay, Bombay

INTRODUCTION

THE absorption and fluorescence spectra of Pr^{3+} ion embedded in various solid matrices have been investigated by several workers in the past.[1,2] Recently some authors[3-5] have reported the fluorescence spectra of certain rare earths doped in NaCl and KCl matrices. The absorption and fluorescence spectra of praseodymium doped in NaCl, KCl and KBr matrices have been the subject of considerable investigation in this laboratory for some time. The results obtained in the spectrum of praseodymium in the KCl matrix are reported in this communication.

EXPERIMENTAL

Single crystals of KCl doped with praseodymium were grown in the following way. Praseodymium oxide was treated with HCl and the chloride solution thus obtained was added to KCl solution so as to obtain 1% concentration of Pr ions in the mixture. The mixture was evaporated to dryness under an infra-red lamp. The dry residue was then transferred to a distillation tube which was attached to a high vacuum line. The tube was heated under vacuum to a temperature of 120–130° C. and

continuously evacuated for 72 hours so as to remove all water of hydration. When this was achieved, the temperature of the tube was further raised to about 900° C. so that its contents could be quickly distilled off. The distillate was collected under vacuum into a vycor crystal-growing tube, which was then filled with dry helium to a pressure of a few cm. of Hg and sealed off from the vacuum line. The crystal-growing tube was then suspended and gradually lowered in the temperature gradient furnace (Stockbarger method), the usual procedure and precautions for growing a crystal as described elsewhere[6] being adopted.

When the crystal was finally obtained it was found that its upper part was opaque and yellowish-green in colour. This indicates a high concentration of praseodymium in this part of the crystal. The lower part of the crystal was transparent and practically colourless. This portion of the crystal, without removing it from the vycor outer cover, was used to study the absorption and fluorescence spectra of the crystal at liquid nitrogen temperature.

For absorption experiments a tungsten ribbon filament lamp (3 V, 80 A) was used as the source of continuous radiation, while a high

pressure Xenon arc lamp was used with suitable filters for exciting the fluorescence spectrum. The Steinheil 3-prism glass spectrograph with the medium dispersion camera and 3·4 meter Jarrel-Ash grating spectrograph were used to photograph the spectra.

DISCUSSION

Figures 1 and 2 show respectively the absorption and fluorescence spectra of praseodymium recorded in the present investigations. The spectra consist of groups of fairly sharp and in some cases broad and diffuse lines which lie
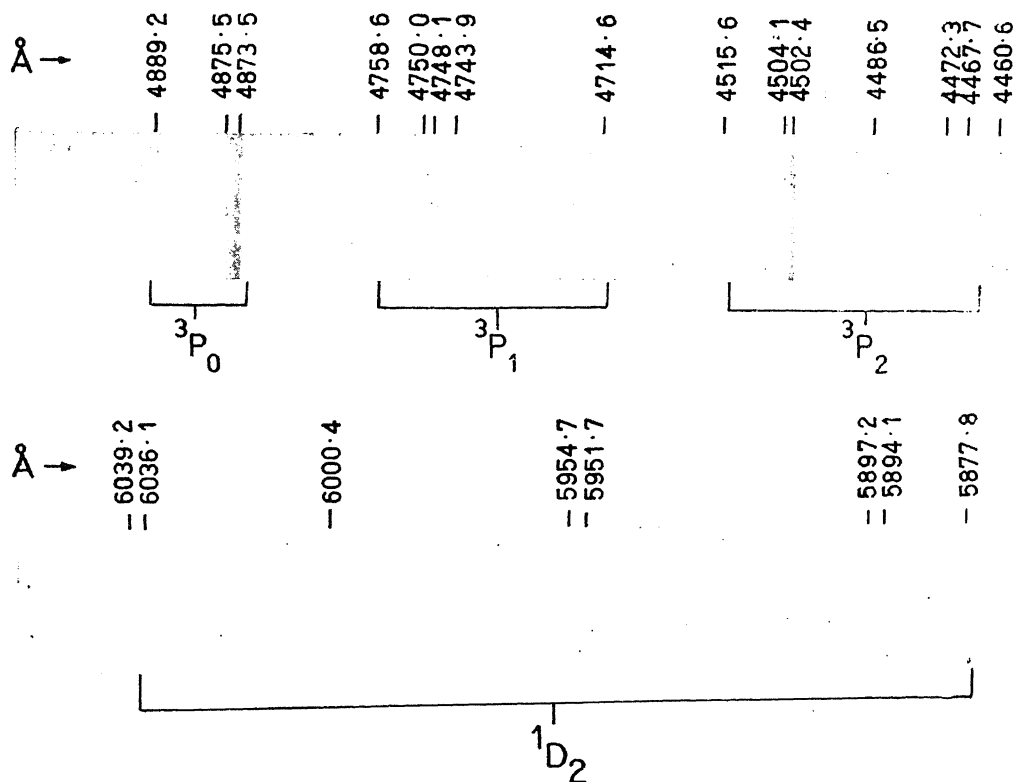

FIG. 1. Absorption spectrum of Pr^{3+} in KCl matrix.
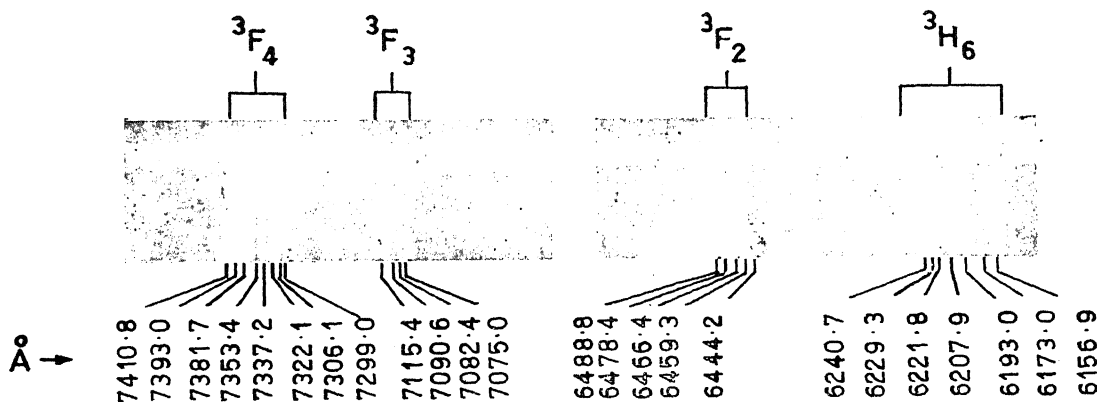(All transitions are from $^3H_4$ ground state)

FIG. 2. Fluorescence spectrum of Pr^{3+} in KCl matrix.
(All transitions are from $^3P_0$ excited state)

near about the same positions as in the corresponding spectra of the Pr^{3+} ion in $PrCl_3$, $(Pr + La)Cl_3$, etc., crystals.[7] The wavelengths of the spectral lines have been measured and the relative intensities estimated. A comparison of these data with those already known in the literature for the Pr^{3+} ion shows beyond doubt that praseodymium is in the triply ionized state in the KCl matrix. A tentative analysis of the observed absorption and fluorescence spectra has been made and the energy levels obtained are given in Table I. The first column in Table I gives the terms and the observed

TABLE I

Energy levels of Pr^{3+} ion in KCl matrix

Term		Term value in cm.$^{-1}$	
$^3H_4$	a	0	(13)
	b	8·6	(6)
	c	65·5	(3)
$^3H_6$	a	4276·1	(1)
	b	4318·5	(1)
	c	4370·3	(1)
	d	4409·5	(1)
	e	4445·5	(1)
	f	4464·9	(1)
	ζ	4494·2	(1)
$^3F_2$	a	5000·1	(1)
	b	5036·3	(1)
	c	5053·3	(1)
	d	5081·9	(1)
	e	5105·7	(1)
$^3F_3$	a	6383·2	(1)
	b	6398·0	(1)
	c	6414·3	(1)
	d	6463·4	(1)
$^3F_4$	a	6816·9	(1)
	b	6830·2	(1)
	c	6860·4	(1)
	d	6888·2	(1)
	e	6918·2	(1)
	f	6970·3	(1)
	g	6991·0	(1)
	h	7023·5	(1)
$^1D_2$	a	16562·4	(2)
	b	16660·9	(1)
	c	16797·3	(2)
	d	16961·4	(2)
	e	17008·5	(1)
$^3P_0$	a	20513·6	(3)
$^3P_1$	a	21055·2	(2)
	b	21074·0	(2)
	c	21204·6	(1)
$^3P_2$	a	22204·4	(3)
	b	22282·8	(1)
	c	22353·8	(1)
	d	22376·6	(1)
	e	22412·4	(1)

Stark components, which are designated a, b, c, etc., in the order of increasing energy. The figures inside the brackets, in column 2, represent the number of observed transitions involving that level.

The absorption spectrum seems to have revealed all the expected transitions in the region investigated. In absorption spectrograms of multicrystals of Pr^{3+} in KCl matrix, some weak lines are found near about 4650 A which most likely involve absorption to the $^1I_6$ state. Further experiments will make the situation clear. The fluorescence spectrum shows only four groups of lines all arising from the $^3P_0$ state. This shows that in the KCl matrix, the $^3P_1$ and $^1D_2$ states, which give rise to fluorescence transitions in the anhydrous $(Pr + La)Cl_3$, etc., matrices, are not fluorescent. On the other hand it may be noted that transitions from the $^3P_0$ level to the $^3F_3$ level, which have not so far been observed in the fluorescence spectra of the Pr^{3+} ion in other matrices, seem to occur in the KCl matrix.

From Table I it may be observed that in some terms, *viz.*, $^3F_2$, $^3F_4$, $^1D_2$, and $^3P_2$ the degeneracy is either completely or almost completely removed. This indicates that the Pr^{3+} ion has only a low site symmetry in the KCl matrix.

Single crystals of NaCl and KBr doped with Pr are also grown by the same method. The absorption and fluorescence spectra of Pr in the KBr matrix are similar in their structure to those in the KCl matrix; the line groups are in general displaced to the longer wavelength side. The spectra of Pr in the NaCl matrix are very diffuse. These and other details of the Pr^{3+} spectra in the different matrices will be communicated separately.

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MASS QUANTISATION OF HALF-SPIN PARTICLES

A. V. LAGU
Department of Physics

AND

S. V. LELE
Department of Metallurgy, Banaras Hindu University, Varanasi, India

1. INTRODUCTION

STEPHENSON[1] has considered the consequences of defining an elementary particle as a region of space-time in which the metric signature is $+4$ while outside the elementary particle the signature is -2. He concludes that a mass spectrum for zero-spin particles can be obtained by using this definition and the Klein-Gordon equation. Lele and Lagu[2] have shown that a similar conclusion can be arrived at by defining the elementary particle as a region of space-time in which the metric signature is $+2$, the metric signature outside the elementary particle being -2. In the present paper an attempt has been made to derive a Fermion (spin ½ particle) mass spectrum by treating the Dirac equation in the same way.

2. SPHERICAL WAVE SOLUTIONS OF THE DIRAC EQUATION

Dirac equation for a free particle is

$$\mathrm{E}\psi = (c\alpha\cdot p + \beta m_0 c^2)\,\psi \qquad (1)$$

where the terms have their usual meanings and E and p should be taken as operators. This can also be written as

$$\frac{1}{c}\frac{\partial\psi}{\partial t} + \sum_{k=1}^{3} \alpha_k \frac{\partial\psi}{\partial x_k} + i\frac{m_0 c}{\hbar}\beta\psi = 0, \quad i = \sqrt{-1} \quad (2)$$

The above equation is equivalent to four equations for the four components of ψ. To write the equations in spherical polar co-ordinates, we make the following transformations[3]:

$$\left. \begin{array}{l} \psi_1 = i\,(l+m)\,F\,(r)\,Z_{l-1}^{m} \\[4pt] \psi_2 = -\,i\,(l-m-1)\,F\,(r)\,Z_{l-1}^{m+1} \\[4pt] \psi_3 = G\,(r)\,Z_l^{m} \\[4pt] \psi_4 = G\,(r)\,Z_l^{m+1} \end{array} \right\} \qquad (3)$$

where

$$Z_l^{m} = \sqrt{\frac{4\pi}{(2l+1)}\,(l+m)!\,(l-m)!}\;Y_{lm} \qquad (4)$$

and Y_{lm} are the well-known Spherical Harmonics. The above equations for a free particle, therefore, reduce to

$$-\frac{(m_0 c^2 - \mathrm{E})}{\hbar c}\,F + \frac{d\mathrm{G}}{dr} + \frac{(l+1)}{r}\,\mathrm{G} = 0 \qquad (5)$$

and

$$\frac{(-\mathrm{E} - m_0 c^2)}{\hbar c}\,\mathrm{G} + \frac{d\mathrm{F}}{dr} - \frac{(l-1)}{r}\,\mathrm{F} = 0 \qquad (6)$$

where $l = 1, 2, 3, \ldots$ but not zero.

Because we are interested only in static solutions, the above equations reduce to

$$-\frac{m_0 c}{\hbar}\,F + \frac{d\mathrm{G}}{dr} + \frac{(l+1)}{r}\,\mathrm{G} = 0 \qquad (7)$$

and

$$-\frac{m_0 c}{\hbar}\,\mathrm{G} + \frac{d\mathrm{F}}{dr} - \frac{(l-1)}{r}\,\mathrm{F} = 0 \qquad (8)$$

Let $f(r) = r\,F(r)$ and $g(r) = r\,G(r)$, the equations (7) and (8) become

$$-\mu f + \frac{dg}{dr} + \frac{l}{r}\,g = 0 \qquad (9)$$

and

$$-\mu g + \frac{df}{dr} - \frac{l}{r}\,f = 0 \qquad (10)$$

where

$$\mu = \frac{m_0 c}{\hbar}.$$

Substituting the value of f from (9) in (10), and similarly substituting the value of g from (10) in (9), we obtain

$$\frac{d^2 f}{dr^2} - \left(\mu^2 + \frac{l\,(l-1)}{r^2}\right) f = 0 \qquad (11)$$

and

$$\frac{d^2 g}{dr^2} - \left(\mu^2 + \frac{l\,(l+1)}{r^2}\right) g = 0 \qquad (12)$$

These are well-known differential equations and the solutions are

$$f = r^{1/2}\,[A_1 I_{(l-1/2)}\,(\mu r) + B_1 K_{(l-1/2)}\,(\mu r)] \qquad (13)$$

and

$$g = r^{1/2}\,[C_1 I_{(l+1/2)}\,(\mu r) + D_1 K_{(l+1/2)}\,(\mu r)] \qquad (14)$$

where A_1, B_1, C_1, D_1 are arbitrary constants. I and K are Modified Bessel Functions of first and second kind of the order indicated by suffixes.

Hence the spherical wave static solutions of the Dirac equation for a free particle are

$$\psi_1 = i\,(l+m)\,r^{-1/2}\,[A_1 I_{(l-1/2)}\,(\mu r)$$
$$+ B_1 K_{(l-1/2)}\,(\mu r)]\,Z_{l-1}^m$$
$$\psi_2 = -i\,(l-m-1)\,r^{-1/2}\,[A_1 I_{(l-1/2)}\,(\mu r)$$
$$+ B_1 K_{(l-1/2)}\,(\mu r)]\,Z_{l}^{m+1}$$
$$\psi_3 = r^{-1/2}\,[C_1 I_{(l+1/2)}(\mu r) + D_1 K_{(l+1/2)}(\mu r)]\,Z_l^m$$
$$\psi_4 = r^{-1/2}\,[C_1 I_{(l-1/2)}(\mu r) + D_1 K_{(l+1/2)}(\mu r)]\,Z_l^{m+1}$$

$$(15)$$

3. Mass Quantisation

Following Stephenson we make the imaginary space co-ordinate transformation

$$x \to ix, \quad y \to iy, \quad z \to iz, \quad t \to t$$

that is

$$r \to ir, \quad \theta \to \theta, \quad \phi \to \phi, \quad t \to t$$

in the Dirac equation to obtain a condition which leads to mass quantisation. The equations (7) and (8), after transformation, become

$$-i\,\frac{m_0 c}{\hbar}\,F_1 + \frac{dG_1}{dr} + \frac{(l+1)}{r}\,G_1 = 0$$
$$-i\,\frac{m_0 c}{\hbar}\,G_1 + \frac{dF_1}{dr} - \frac{(l-1)}{r}\,F_1 = 0$$

and their solutions are

$$\xi_1 = i\,(l+m)\,r^{-1/2}\,[A_2 J_{(l-1/2)}\,(\mu r)$$
$$+ B_2 Y_{(l-1/2)}\,(\mu r)]\,Z_{l-1}^m$$
$$\xi_2 = -i\,(l-m-1)\,r^{-1/2}\,[A_2 J_{(l-1/2)}\,(\mu r)$$
$$+ B_2 Y_{(l-1/2)}\,(\mu r)]\,Z_{l-1}^{m+1}$$
$$\xi_3 = r^{-1/2}\,[C_2 J_{(l-1/2)}\,(\mu r) + D_2 Y_{(l+1/2)}(\mu r)]\,Z_l^m$$
$$\xi_4 = r^{-1/2}\,[C_2 J_{(l+1/2)}(\mu r) + D_2 Y_{(l+1/2)}(\mu r)]\,Z_l^{m-1}$$

$$(16)$$

where A_2, B_2, C_2, D_2 are again arbitrary constants. J and Y are Bessel Functions of first and second kind of the order indicated by suffixes.

Thus the wave function of the elementary particle within a sphere of radius R is given by (16) while outside the sphere it is given by (15). To exclude singularities at infinity in ψ and at the origin in ξ, we put $A_1 = C_1 = 0$ and $B_2 = D_2 = 0$ respectively. Imposing the requirement of continuity at $r = R$ which is

$$(\psi_i)_{r=R} = (\xi_i)_{r=R}$$

and

$$\left(\frac{\partial \psi_i}{\partial r}\right)_{r=R} = \left(\frac{\partial \xi_i}{\partial r}\right)_{r=R}$$

where R is the radius of the sphere across which the metric signature changes and $i = 1, 2, 3, 4,$

we find four conditions which are identical in pairs and hence we get only two conditions. No specific conditions for mass quantisation can be obtained unless the value of l is fixed. Taking a simple case, we put $l = 1$, which is the lowest possible value of l, and obtain the two conditions as

$$\tan \mu R = -1 \qquad \text{for} \quad i = 1, 2 \qquad (17)$$

and

$$\tan \mu R = \frac{\mu R}{\mu R + 2} \qquad \text{for} \quad i = 3, 4 \qquad (18)$$

The solutions for equation (17) are

$$\mu_n R = \frac{3\pi}{4} + n\pi \qquad (19)$$

where n is 0, 1, 2, 3, ... and the solutions of equation (18) can be found by approximate methods. These reduce to

$$\mu_n R = \frac{\pi}{4} + n\pi \quad \text{for large } n. \qquad (20)$$

4. Conclusion

It has been shown for zero-spin particles[2] that both real and imaginary time co-ordinate transformations lead to the same condition for mass quantisation although the two transformed wave equations become invariant under orthogonal and Lorentz transformations respectively. It can be shown for half-spin particles considered here, that the conditions (19) and (20) can again be obtained by considering the transformation

$$x \to ix, \quad y \to iy, \quad z \to iz, \quad t \to it$$

also.

It is interesting to note that the solution (19) is identical with that obtained by Stephenson for zero-spin particles. Further the solutions (19) and (20) lead to mass quantisation independently, but are incompatible with each other. An interpretation of this interesting result and the invariance of the wave equations will be discussed later.

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LETTERS TO THE EDITOR

PROTON MAGNETIC RESONANCE SPECTRA OF PYRIDINE N-OXIDE, 4-SUBSTITUTED PYRIDINE N-OXIDES AND THEIR COMPLEXES WITH URANYL CHLORIDE

IN recent years there has been renewed interest in the pyridine N-oxide complexes of transition metals. There have been many papers on the infra-red spectra, electronic spectra and the magnetic susceptibilities of the complexes of pyridine N-oxides.[1-7] In this paper the proton resonance spectra of pyridine N-oxide (PyO), 4 methoxypyridine N-oxide (PyO·OCH₃), 4-methyl pyridine N-oxide (PyO.CH₃) and 4-nitropyridine N-oxide (PyO.NO₂) and of their complexes with uranylchloride, viz., UO₂Cl₂(PyO)₄, UO₂Cl₂(PyO.OCH₃)₂, UO₂Cl₂(PyO.CH₃)₂ and UO₂Cl₂(PyO.NO₂)₂, are described. The preparation, purification, infra-red and the electronic spectra of these complexes will be the subject of another paper to be published elsewhere.[8] These compounds were dissolved in deuterated dimethylsulphoxide and the proton chemical shifts were measured in p.p.m. relative to the protons in dimethylsulphoxide as an internal standard on a Varian HR-60 spectrometer. The results are presented in Table I.

Chemical Shifts.—The hetero group and the substituent at the position 4 can have considerable influence on the α-protons and this effect can be distinguished clearly in the case of free ligands. The tendency for the α-protons to become less shielded (within the limits of experimental error) is apparent as the nature of the substituent varies from strongly electron donating (*e.g.*, OCH_3) to strongly electron withdrawing (*e.g.*, NO_2) (Table I). This is in agreement with similar observations made by Katritzky and Lagowski.[9] The electron density at the α-proton decreases in the order $OCH_3 \sim CH_3 > H > NO_2$.

In the case of complexes, the peak positions of the α-protons do not change in any regular manner with the change in the nature of the substituent probably because of the effect of the metal atom co-ordinated to the oxygen of the NO group in the ligand. However, it can be seen that these protons in general are less shielded than those of the free ligands (Table I) indicating that the pyridine ring of the ligand when co-ordinated to the metal becomes deficient in electrons at the α-positions as would be expected.[9] The difference between the chemical shifts for the α-protons of the complex and the ligand $\delta_1' - \delta_1$ $(\triangle\delta_1)$ (Table I)

TABLE I

Ring proton chemical shifts of pyridine N-oxide and 4-substituted pyridine N-oxides and their uranyl complexes and the N⁺-O⁻ stretching frequencies

Chemical shifts of ring protons in p.p.m. (± 0.05) relative to dimethyl sulphoxide

Substituent	$N^+ - O^-$ str. (Cm.⁻¹) of complexes (8)	Free ligand		Complex		$\triangle\delta_1 = \delta_1' - \delta_1$	$\triangle\delta_2 = \delta_2' - \delta_2$
		α-proton (δ_1)	β-proton (δ_2)	α-proton (δ_1')	β-proton (δ_2')		
-H	1216	-5.90	-4.89	-5.77	-5.04	-0.17	-0.15
-CH₃	1210	-5.49	-4.74	-5.72	-4.82	-0.23	-0.08
-OCH₃	1205	-5.50	-4.39	-5.79	-4.58	-0.29	-0.19
-NO₂	1235	-5.74	-5.69	-5.75	-5.66	-0.01	-0.03

Due to the limited solubility of these compounds in dimethylsulphoxide relatively dilute solutions (2-5% w/v) were used for these measurements and solvent effects were assumed to be negligible. To check this assumption, a spectrum of the most soluble 4-methoxy complex was studied at different concentrations and it was observed that dilution had no effect on the chemical shifts of α- and β-protons within the limits of experimental error.

therefore can be taken as a measure of the strength of the bond between the metal and the ligand. When the N⁺-O⁻ stretching frequencies of the ligands in the complexes which also reflect the strength of the metal-ligand bond[8] are plotted against the chemical shifts for the α-protons, a linear relation is obtained (Fig. 1) thus confirming the evidence obtained from vibrational spectra.[8] Similar linear relations between the proton chemical shifts and

the CH deformation frequency of a series of substituted quinolines have also been observed.[10] It is interesting to note that recently Kuhn and McIntyre[11] have measured
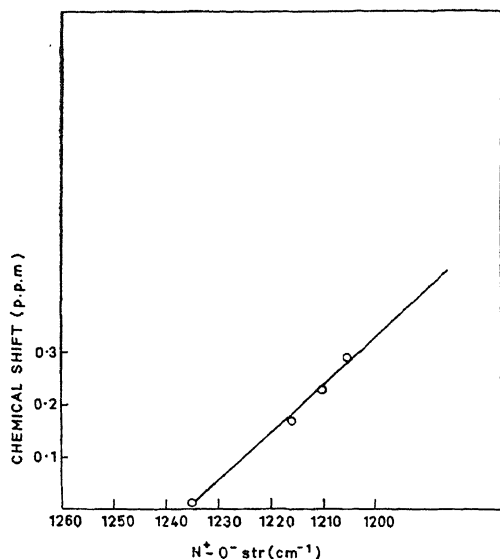

FIG. 1

the proton resonance spectra of a number of Lewis acid-N, N'-dimethyl formamide adducts and correlated the strength of Lewis acids with the chemical shifts of the methyl protons in good agreement with the results of the infra-red studies.

The β-protons in all these complexes are also generally less shielded than those of the free ligands (Table I). However $\delta_2' - \delta_2$ ($\Delta \delta_2$) values do not show any regular variation with the nature of the ligand. This can be understood from the fact that the β-protons being close to the substituent at the 4-position are likely to be influenced predominantly by the nature of the substituent.

The results discussed in this note show that there is a correlation between the infra-red and NMR data for these complexes. Such correlations in other systems and their importance in understanding the structure of complexes have been discussed by Finegold.[12]

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STUDY OF THE ELECTRONIC STRUCTURE OF α AND β BIS (PYRIDINE) COBALT (II) CHLORIDE BY X-RAY SPECTROSCOPY

THERE exist two forms of *bis* (pyridine) cobalt (II) chloride $\{Co(C_5H_5N)_2Cl_2\}$, namely, a violet α form and a blue β form. Considerable work on their molecular weight,[1] structure,[1,2] magnetic properties,[3,4] absorption spectra,[5] and thermal properties[6] has been done. Recently Wendlandt[7] has studied $\alpha \rightarrow \beta$ transition of *bis* (pyridine) cobalt (II) chloride by differential thermal analysis (DTA) and by dynamic reflectance spectroscopy (DRS). He has shown that at 125° C. the violet α form changes completely to the blue β form. We thought it interesting to study the K absorption spectrum of cobalt in both these forms in order to confirm the co-ordination number of the Co^{++} ion in them as obtained by other methods and to throw some light on the nature of bonding in these complexes,

The experimental set-up for obtaining the spectra has been described in earlier papers.[8-10] The complexes were prepared following the method described by Cox, Shorter, Wardlaw and Way.[1]

Several microphotometer records of the cobalt K absorption spectra in α and β forms were obtained. Two representative microphotometer curves of the cobalt K edge in the α and β forms are shown in Figs. 1 and 2 respectively. The K absorption curve obtained for the α form is characteristic of the central transition metal ion associated with an octahedral surrounding while the curve obtained for the β form is characteristic of the metal ion with a tetrahedral surrounding.[11] This work thus supports the stereochemical results of previous workers. The splitting of the principal K absorption edges of tetrahedral complexes (here β form) has been explained by Sinha and Mande[11] on the basis of the ligand field theory. According to them, in such cases the empty 4p orbital is localized, making possible the X-ray absorption transition $1s \rightarrow 4p$.

According to Figgs and Nyholm,[12] the magnetic moment of cobalt (II) complexes should lie between the limits $\mu_{eff} = \sqrt{4S(S+1)} = 3 \cdot 88$ B.M. and $\mu_{eff} = \sqrt{4S(S+1) + L(L+1)} = 5 \cdot 2$ B.M. where S and L have their usual significance. The magnetic moments of the α and β forms of this complex as obtained by Barkworth and Sugden[4] are $5 \cdot 34$ B.M. and $4 \cdot 60$ B.M. respectively. The value of the magnetic moment for the α form seems to be somewhat high. This high value of the magnetic moment can probably be attributed to an enhanced g_{eff} (Landé's factor) due to spin orbital interaction.[13]

Two hybridizations d^2sp^3 and sp^3d^2 are possible for an octahedral structure.[14] Octahedral cobalt (II) complexes with d^2sp^3 hybridization have low magnetic moment due to the presence of only one unpaired electron. The high value of the magnetic moment for the α form thus suggests sp^3d^2 hybridization.

For tetrahedral complexes the possible hybridizations[14] are d^3s and sp^3. Mellor and Coryell[3] have suggested sp^3 hybridization for the β form. However, according to the present X-ray study, the 4p orbital is localised and does not take part in bonding. Thus the more likely hybridization is d^3s for the β form.

An alternative method to explain the bondings is given by the molecular orbital theory.[13,15] In an octahedral complex

only the ligand p_σ orbitals take part strongly in the bonding and antibonding admixtures. Thus we take 19 electrons in all, 12 from the ligands and 7 valence electrons from the Co^{++}

FIG. 1.

FIG. 2.
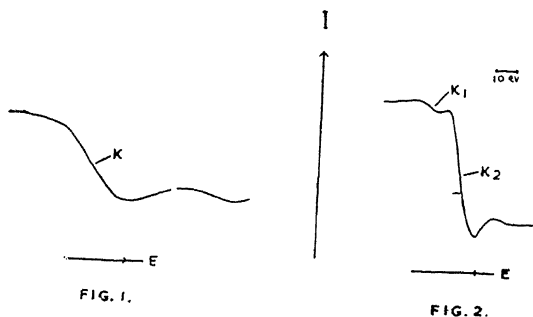
FIGS. 1-2 show the form of the CoK absorption edge in the α and β *bis* (pyridine) cobalt (II) chloride respectively. The curves have been obtained on a Moll Microphotometer with 50 magnifications.

ion, which have to be distributed in the molecular orbitals. The molecular orbitals in increasing order of energy are a_{1g}, t_{1u}, e_g (bonding), t_{2g} (non-bonding) and e_g^*, t_{1u}^*, a_{1g}^* (antibonding). Hence the electronic configuration in the α complex can be described as $a_{1g}^2 \, t_{1u}^6 \, e_g^4 \, t_{2g}^5 \, e_g^{*2}$. In the case of the tetrahedral complex (β form), we have 15 electrons, 8 from the ligands and 7 valence electrons from the Co^{++} ion, to be distributed in the molecular orbitals. The molecular orbitals in increasing order of energy in this case are a_1, t_2 (bonding), e (non-bonding) and t_2^*, a_1^* (antibonding). Hence the electronic configuration in the β form can be described as $a_1^2 \, t_2^6 \, e^4 \, t_2^{*3}$.

Department of Physics,   CHINTAMANI MANDE.
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EFFECT OF TEMPERATURE ON THE SOUND VELOCITY MAXIMUM IN DIOXANE-WATER MIXTURES

X-RAY diffraction,[1] heat of mixing,[2] heat of vapourisation,[3] viscosity,[4] density[5] and microwave absorption studies[6] in the binary system p-dioxane-water, indicate drastic changes in the water structure due to the addition of even small amounts of dioxane. Ultrasonic velocity in this system was studied at 23° C. by Burton[7] and the velocity *versus* concentration graph exhibits a pronounced maximum at about 0·85 molefraction of water. This is the concentration at which other physical properties also exhibit singularities. A study of the effect of temperature on the velocity maximum is likely to give some insight into the relevant mechanism. With this end in view, ultrasonic velocity as a function of composition was studied at 5° C. intervals in the range 25° C.–80° C., using a variable path interferometer. The temperature of the experimental liquid was maintained within ± 0·1° C. and the estimated error in the velocity measurements is ± 0·1%.

Variation of ultrasonic velocity with composition at 25° C., 50° C. and 75° C. is shown in Fig. 1. As the temperature increases the magnitude of the velocity maximum decreases and finally disappears at 75° C. The concentration at which the maximum occurs does not appreciably change with temperature. Adiabatic compressibility *versus* concentration curves (not shown) exhibit minima at about 0·85 molefraction of water. The magnitude of the compressibility minimum decreases with increasing temperature. However, it persists even at 80° C.

X-ray diffraction studies[1] clearly show that the diffraction ring characteristic for water

(*i.e.*, ice-like structure which is believed to be maintained by hydrogen-bonding) is destroyed by addition of even small fractions of dioxane. It can reasonably be assumed that addition of
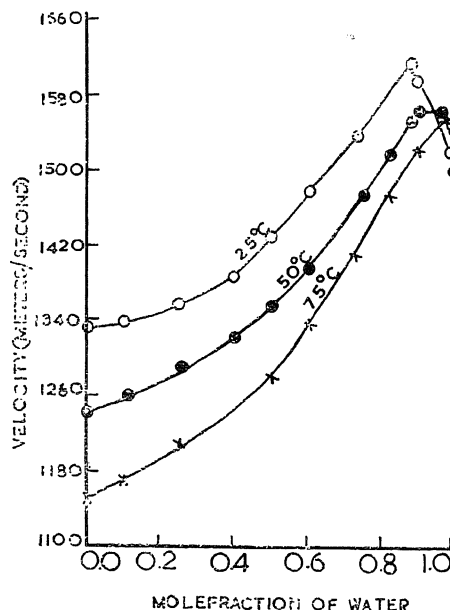

FIG. 1. Variation of ultrasonic velocity in dioxane-water mixtures at different temperatures.

dioxane results in breaking down the rather open ice-like structure to a somewhat close-packed structure. This would result in an increase of velocity as sound waves travel faster in closely packed structures.[8] As we increase the concentration of dioxane, due to the structure-breaking effect, the concentration of the closely packed structure increases with consequent increase in velocity. The velocity reaches a maximum value at a concentration where all the molecules of water having ice-like structure are converted into closely packed ones. This effect is less pronounced at higher temperatures as the number of available ice-like structures in water decreases with increasing temperature. Full details will be published elsewhere.

Department of Physics,   S. V. SUBRAHMANYAM.
Sri Venkateswara Univ.,   K. RAGHUNATH.
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MEAN AMPLITUDES OF VIBRATIONS OF NITRYL FLUORIDE AND NITRYL CHLORIDE

THE authors have earlier subjected nitryl fluoride and nitryl chloride to normal co-ordinate treatment by using the most general quadratic form of potential energy expression.[1] The molecules were assumed to have planar configuration with a symmetry of the point group C_{2v}. The computations have now been extended to calculate the mean amplitudes of vibrations of the valence linkages N–F, N–O and N–Cl. The authors have sketched the theory of the evaluation of mean amplitudes of vibrations of bonds elsewhere.[2] Applying those methods the results obtained in the cases of the first two nitryl halides are given in Tables I and II. The percentage contribution of each

TABLE I
Nitryl fluoride

Normal co ordinate Q	Frequency cm.$^{-1}$	m.s.a. of N–F bond $\times 10^{-4}$ A^2	% contribution	m.s.a of N–O bond $\times 10^{-4}$ A^2	% contribution
Q_1	1312	0·6431	2	4·6287	34
Q_2	822	23·4414	84	0·3967	3
Q_3	460	3·7976	14	0·0328	..
Q_4	1793	..	..	8·6629	63
Q_5	570	..	..	0·0767	..
Mean square amplitude		27·8821		13·9978	

Mean amplitude of N–F bond = 0·053 Å
Mean amplitude of N–O bond = 0·037 Å

TABLE II
Nitryl chloride

Normal co-ordinate Q	Frequency cm.$^{-1}$	m.s.a. of N–Cl bond $\times 10^{-4}$ A^2	% contribution	m.s.a. of N–O bond $\times 10^{-4}$ A^2	% contribution
Q_1	1293	4·2955	21	3·0655	25
Q_2	794	13·4366	65	0·2257	2
Q_3	411	2·8742	14	0·0306	..
Q_4	1685	..	..	8·7144	72
Q_5	367	..	..	0·0228	..

of the normal co-ordinates to the mean square amplitudes have also been given.

Department of Physics,   P. G. PURANIK.*
Univ. College of Science,   E. V. RAO.
Osmania University,
Hyderabad (A.P.), *July* 19, 1965.

* Present Address : Nizam College, Hyderabad.

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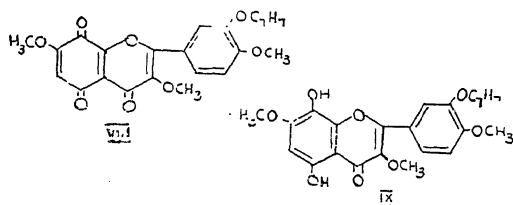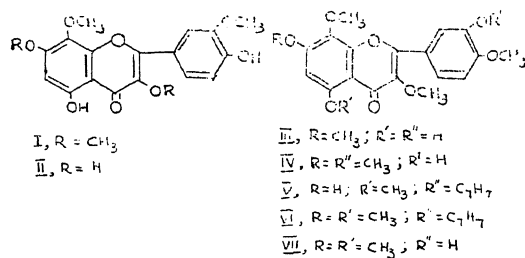2. — and —, *Proc. Ind. Acad. Sci.*, 1963, **58**, 368.

SYNTHESIS OF 3, 7, 8, 4'-O-TETRAMETHYL GOSSYPETIN

A NUMBER of ethers of gossypetin occur in nature besides one which has methylenedioxy group. Four partial methyl ethers are known : ternatin (I),[1] limocitrin (II),[2] gossypetin tetramethyl (III) and pentamethyl (IV) ethers.[3] Of these the tetramethyl ether (III) is a recent discovery and was found to be one of the components of *Ricinocarpus stylosus* by Henrick and Jefferies.[3] The structure was given on the basis of methylation studies and degradation reactions. Further support was provided by U.V. and N.M.R. studies. No synthetic confirmation was, however, provided. As part of a programme of syntheses of the partial methyl ethers of gossypetin we have been able to effect the synthesis of (III) by two methods. The synthetic sample agrees in its m.p., colour reactions and U.V. spectral characteristics with those reported for (III) obtained from natural source and hence provides confirmation for the constitution proposed.

Method I.—The synthesis starts from 2, 4-dihydroxy-ω, 3, 6-trimethoxy acetophenone[4] which was subjected to Allan-Robinson condensation with the anhydride and sodium salt of benzyl isovanillic acid. The flavonol (V) obtained, m.p. 215-17°, was methylated and the resulting methyl ether (VI), m.p. 165–67°, was subjected to catalytic debenzylation. The product (VII), m.p. 214–15°, was partially demethylated using aluminium chloride in acetonitrile to give the required flavonol (III), m.p. 184–85° (reported value[3] 184–85°), mixed m.p. with the natural sample undepressed.

Method II.—In this method compound (VI) was subjected to oxidative demethylation to yield the quinone (VIII), m.p. 205–06°. This was reduced to the quinol (IX), m.p. 184–85°, which on partial methylation at the 8-position followed by catalytic debenzylation gave (III). The acetate had m.p. 176–77° (reported

value[3] 179–80°); mixed melting point with the diacetate of the natural sample was undepressed.

I, R = CH₃
II, R = H

III, R = CH₃ ; R' = R'' = H
IV, R = R'' = CH₃ ; R' = H
V, R = H ; R' = CH₃ ; R'' = C₇H₇
VI, R = R' = CH₃ ; R'' = C₇H₇
VII, R = R' = CH₃ ; R'' = H

VIII

IX

Our thanks are due to Dr. P. R. Jefferies for an authentic sample of 3, 7, 8, 4'-O-tetramethyl gossypetin and its acetate.
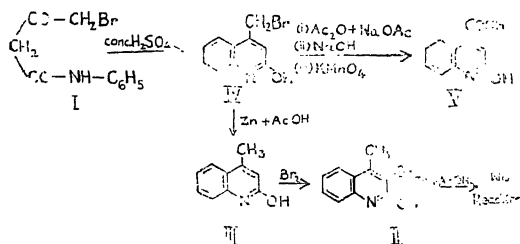
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BROMINATION OF ACETOACETANILIDE : A REVISION OF STRUCTURE

Knorr[1] brominated acetoacetanilide in chloroform solution and claimed to have obtained α-bromoacetoacetanilide. Hasegawa[2] and Cook et al.[3] repeated the above experiment in chloroform and gave ω-bromoacetoacetanilide (I) structure to this product. Mehta and coworkers[4,5] brominated acetoacetanilide in acetic acid solution and claimed to have obtained α-bromoacetoacetanilide. They further reported that this product on cyclisation gave 3-bromo-4-methyl-2-hydroxyquinoline (II) which was identical with the product obtained on bromi-

nation of 4-methyl-2-hydroxyquinoline (III). In view of these contradictory reports, it was thought of interest to repeat the work by both the procedures. In both the cases, the same product (Found : N = 5·84%, Br = 31·69% ; C₁₀H₁₀O₂BrN requires: N = 5·46%, Br = 31·25%) with m.p. and mixed m.p. 135–36° was obtained. The product is assigned ω-bromoacetoacetanilide structure on the basis of the following series of reactions. It gave on cyclisation with concen-

trated sulphuric acid 4-bromomethyl-2-hydroxyquinoline (IV), m.p. 254–56° which is different from the 3-bromo-4-methyl-2-hydroxyquinoline (II) (Found : N = 5·84%, Br = 33·97% ; C₁₀H₈ONBr requires : N = 5·88%, Br = 33·61%), m.p. 274° obtained by the bromination of 4-methyl-2-hydroxyquinoline. 4-Bromomethyl-2-hydroxyquinoline (IV) is converted to known 2-hydroxy cinchoninic acid[6] (V) (Found : N = 7·14% ; C₁₀H₇O₃N requires : N = 7·4%) by treatment with acetic anhydride and fused sodium acetate followed by hydrolysis and oxidation with KMnO₄. 4-Bromomethyl-2-hydroxyquinoline (IV) on reduction with zinc and acetic acid gave 4-methyl-2-hydroxyquinoline (III) while 3-bromo-4-methyl-2-hydroxyquinoline (II) remained unaffected under similar conditions.

The authors record their thanks to Dr. S. S. Lele for carrying out the microanalysis.

Chemistry Department,   R. J. Chudgar.
Faculty of Science,   K. N. Trivedi.
M.S. University of Baroda,
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INFLUENCE OF TEMPERATURE ON THE PHOTOMETRIC DETERMINATION OF SILICON BY THE MOLYBDENUM BLUE METHODS

PHOTOMETRIC determinations of silicon in ferrous and non-ferrous materials have become increasingly popular owing to their speed and simplicity, coupled with accuracy, as compared with conventional gravimetric methods. Broadly speaking, two types of procedures are in vogue, namely, (*a*) those which depend on the colour intensities of yellow silicomolybdate and (*b*) those where the silicomolybdate is reduced to the blue complex. Owing to the greater sensitivity[1] and better stability[2] of the colour involved, the procedures employing the blue complex are more generally adopted. An examination of the literature[3-11] shows that temperature exerts some influence on the intensity and stability of the colour. There is, however, much need for exhaustively examining this effect by systematic studies with a view to assess its influence on the accuracy of colorimetric estimations when carried out in tropical countries like India where sometimes the laboratory temperatures go as high as 45° C.

It is not always feasible to equip laboratories with temperature-control devices. It will, therefore, be advantageous to overcome the influence of temperature by suitably modifying the existing procedures or evolving fresh ones if necessary. Investigations were therefore undertaken in this regard and they have yielded promising results.

In the present investigations stannous chloride, ferrous ammonium sulphate and ascorbic acid were employed as reducing agents and the influence of time and temperature examined when applied in different media. The experiments were confined to pure silicate solutions. Other essential details were governed by the procedures given in Table I.

The main features of our findings may be summarized as follows :

(1) The use of stannous chloride as a reducing agent results in increasing the colour intensities involved. It also results in a marked influence of temperature and time on the colour intensities in procedures I and II. In case of procedure III, there is a considerable reduction in the influence of temperature and time, even though slightly lower colour intensities have been obtained. For successful adoption, however, it is imperative that the initial acid concentration should be rigidly controlled.

(2) When ferrous ammonium sulphate is used as a reducing agent, the colour intensities are of much lower order and are also appreciably influenced by temperature and time intervals in procedures I and II. This influence is very much reduced in case of procedure III and practically disppears at lower silicon concentrations (less than 40 µg.). This, therefore, lends itself for successful adoption, provided the silicon concentrations are kept sufficiently low and the initial acid concentration is properly maintained.

(3) The use of ascorbic acid had resulted in some rather remarkable observations and there is practically no influence of temperature and time intervals on the colour intensities in all the procedures under consideration. Initial acid concentration exerts only a negligible influence.

TABLE I

	Initial acid concentration for developing the silico-molybdate	Molybdate for development	Reducing agent	Acid medium during the reduction of silico-molybdate
Procedure I[12]	1 ml. of 25% H₂SO₄	10 ml. of 5% Ammonium Molybdate	10 ml. of 0·05% Stannous chloride	10 ml. of 2 % H₂SO₄
Procedure II[13]	0·8 ml. of 25% H₂SO₄	5 ml. of 5% Ammonium molybdate	10 ml. of 10% Ferrous ammonium sulphate	16 ml. of 25% H₂SO₄
Procedure III[14]	0·8 ml. of 25%	10 ml. of 2·5% Ammonium molybdate	5 ml. of 10% Ferrous ammonium sulphate	10 ml. of 4% Oxalic acid

In conclusion it may be pointed out that stannous chloride or ferrous ammonium sulphate does not give satisfactory results, whatever may be the media employed for reduction. However, the oxalic acid medium[14] affords a definite advantage over the sulphuric acid medium[12,13] with regard to the influence of temperature and time and hence commends itself for adoption wherever possible. It is, indeed, quite significant that the use of ascorbic

acid as a reducing agent can result in successfully overcoming the influence of temperature on the photometric estimation of silicon in tropics. Full details giving further particulars will shortly be published elsewhere.

Our thanks are due to the management of the Tata Iron and Steel Company for permitting the publication of this note.

Dept. of Chem. Labs..   G. V. L. N. MURTY.

The Tata Iron and   K. S. R. KRISHNAIAH.

Steel Co., Ltd.,   M. S. RAJU.

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A NOTE ON RAPID METHOD FOR ANALYSIS OF LIMESTONE AND DOLOMITE

EVER SINCE ethylenediamine tetra acetic acid. di-sodium salt (EDTA) was used as an analytical reagent. attention was focused on the estimation of calcium and magnesium using various metal indicators.[1,2] Banks[3] studied it on siliceous material using Erichrome Black T for total calcium and magnesium and murexide for calcium. Vogel[4] found murexide indicator far from ideal. Using calcon (Solochrome dark blue) Hillebrand and Reilley[5] had obtained reproducible results with pure salts of calcium and magnesium, using diethylamine buffer. Authors have applied it to siliceous limestones and dolomites introducing hydroxylamine hydrochloride as a stabiliser of the end point when bromine is added to

precipitate manganese and hydrofluorisation is done for estimating silica.

Comparable results have been obtained with calcon, as well as with oxalate methods as can be seen from the summary of analytical results given in Table I.

TABLE I

Comparative statement of the analysis for calcium after H.F. treatment

Sl. No	Sample No.	SiO_2	R_2O_3	$CaCO_3$ by oxalate	$CaCO_3$ by calcon	$MgCO_2$
1	GK/11/8	3·50	2·30	87·06	87·00	5·04
2	GK/1 5	3·14	2·12	83·80	84·00	7·56
3	GK/4/8	3·68	0·96	84·74	85·00	7·14
4	GK/4/15	3·56	2·36	83·00	83·02	8·40
5	GK/4/8	4·14	2·42	83·36	83·00	8·40
6	GK/7/4	4·58	2·84	79·16	79·50	10·08
7	GK/7/3	3·72	2·48	82·88	83·00	7·14
8	GK/11/5	3·88	2·38	86·3	86·50	4·62
9	GK/11/6	4·44	2·46	84·74	85·00	5·88
10	GK/1/8	3·82	2·24	84·43	84·50	5·46

The results by calcon method are comparable with the determination of calcium by oxalate method. End points are much sharper and reproducible than with murexide indicator. Moreover, calcon, and diethylamine are cheaper reagents.

The determination is very quick and accurate. It is highly suitable for field laboratories of varying condition such as temperature, etc. Even 0·01 gm. of limestone was giving excellent reproducible results exactly coinciding with oxalate values so much so that it may be tried to determine lime in silicate analysis even. Dimethylamine buffer was also giving satisfactory end points. Other suitable buffers are under study.

The authors are deeply indebted to Shri S. P. Nautiyal. Superintending Geologist, G.S.I., Mysore Circle, for his valuable advice, guidance and encouragement.

Chemical Laboratory. M. K. R. PANICKER.

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Bangalore-11.   S. GURUPRASAD.

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EFFECTS OF SHORT-TERM STARVATION ON THE METABOLISM OF A FRESH-WATER FISH, *PUNTIUS SOPHORE* (HAMILTON)

THERE are quite a few studies on the effects of prolonged starvation on the metablism of various animals.[3] But there is no information regarding the influence of short-term starvation on the metabolism of any poikilotherm. Hence, the influence of 24-hour starvation on the oxygen consumption of a fresh-water fish, *Puntius sophore*, was studied.

The fish were stocked in the laboratory aquaria and their oxygen consumption was measured at 15° C., 25° C., 30° C. (habitat temperature) and 35° C. Two batches of fish were used—one in a normal feeding state and the other starved for 24 hours prior to the measurements. Oxygen consumption was measured by the Winkler's iodometric method,[8] and the data are presented in Figs. 1–6 and Table I.

TABLE I

Q_{10} values in the fed and starved P. sophore as a function of size and temperature

Weight of fish gm.	Q_{10}					
	15–25° C.		25–30° C.		30–35° C.	
	Fed	Starved	Fed	Starved	Fed	Starved
2	1·690	2·071	2·695	1·869	1·882	1·806
11	1·760	2·023	2·740	3·478	1·613	1·598

The metabolism of the fish was lowered even on a 24-hour starvation (Figs. 1–4). This is of some interest in the light of the fact that digestion of food takes a few days in fishes. But temperature and size of the fish appear to modify the magnitude of the metabolic depression consequent upon starvation. It is obvious that the effects of starvation were greater at the two extremes of the temperature range used. At 30° and 35° C. the smaller fish were more affected than the larger ones, somewhat as in the case of another fresh-water fish, *Etroplus maculatus*.[3] This appears to be in agreement with the findings of Dawes[2] in the plaice, *Pleuronectes*, where the maintenance requirements of food were found to be greater in the smaller fish and at the higher temperature. Both these factors are involved in the present case. The reported higher mortality rate in the smaller individuals of the brook trout, subjected to starvation, also subscribes towards the existence of the influence of size on the effects of starvation.[1] Perhaps, the greater metabolic depression in the smaller

fish may be ascribed to their higher metabolic activity and hence higher metabolic demands, when compared to the larger ones, and to this effect there is already documented evidence in the case of the fish, *Girella nigricans*.[7] That smaller individuals are more affected by starvation was also shown in the earth worm, *Lampito mauritii*.[6]

It is noteworthy that the size-metabolism relation under fed and starved conditions maintained a consistent trend with temperature, being maximal at the habitat temperature and decreasing at the other temperatures, higher as well as lower (Figs. 1–4). Perhaps, nutritional
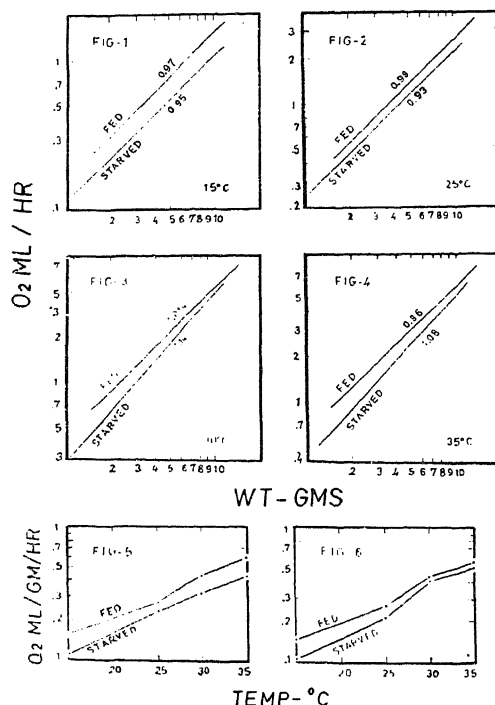
FIGS. 1–6. Figs. 1–4. Oxygen consumption of *P. sophore* as a function of nutritional state at different temperatures. The size-metabolism curves of fed and starved fish at different temperatures are compared. The curves are statistically fitted by the method of least squares and the regression coefficients are indicated on the respective curves. The points are omitted for clarity. Figs. 5–6. Unit oxygen consumption (O_2 ml./gm /hr.) of *P. sophore* of 2 gm. (Fig. 5) and 11 gm. (Fig. 6) weights as a function of nutritional state at different temperatures plotted on semi-log scale. The unit oxygen consumption values are calculated from the curves of Figs. 1–4.

state has no influence on the pattern of temperature dependence of *b* as was also shown for the crab, *Pachygrapsus crassipes*.[5] But, unlike in *P. crassipes*, thermal sensitivity, as measured by Q_{10}, was altered in *P. sophore* even on a 24-hour starvation (Figs. 5 and 6;

Table I). Starvation, but of a long-term duration, modifying thermal sensitivity has also been reported for the crab, *Paratelphusa hydrodromus*.[4] In the starved fish the Q_{10} values are higher between 15° and 25° C. and lower between 30° and 35° C., when compared to the corresponding values of the fed fish (Table I). May be, there was metabolic depression in the starved fish at the two extremes of the temperature range used. Can this metabolic depression be due to the reduced thermal resistance of the fish at the two extreme temperatures, consequent upon starvation?

I thank Prof. K. Pampapathi Rao for his guidance in the course of these investigations.

Dept. of Zoology,   V. PARVATHESWARARAO.
Sri Venkateswara Univ.,
Tirupati (A.P.), *March* 18, 1965.

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THE OCCURRENCE OF THE COCCIDIUM *EIMERIA CHRISTENSENI* IN GOATS IN INDIA

DURING a survey of coccidia of goats in Madhya Pradesh (India) from January to October 1963, 300 faecal samples from apparently healthy goats of various ages and both sexes belonging to the College of Veterinary Science, Mhow (M.P.), were examined. In 5% of the samples coccidial oocysts were encountered that did not resemble those previously reported from goats in this country.[3-7] They were subsequently identified as *Eimeria christenseni* Levine, Ivens and Fritz, 1962.

The oocysts were allowed to sporulate in 2·5% potassium dichromate solution in a thin layer in a petri dish for a week to ten days. They were then studied under oil immersion objective of an "Olympus" microscope.

Description.—The oocysts (Fig. 1) were ovoid, rarely ellipsoidal, and slightly flattened at the micropylar end. Twenty-eight sporulated oocysts measured 32 to 43 by 24 to 30 μ (mean 39 by 26 μ). Oocyst wall composed of two layers,

the outer one smooth, pale-yellowish, about 1·0 μ thick; and the inner one brownish, yellow, 0·4 μ thick; the intact oocysts often appeared to have a colourless outermost layer, 0·3 μ thick, but no evidence of such a layer could be seen in crushed oocysts and its appearance was probably an optical illusion. Micropyle present, at small end of oocyst. Micropylar cap prominent, colourless, mound-shaped; the micropylar caps of twenty-eight sporulated oocysts ranged from 2 to 4 μ high by 5 to 10 μ wide (mean 3 by 7 μ). One or more oocyst polar granules present; among 28 sporulated oocysts, a single polar granule was seen in 2, 2 in 3, 3 in 3, 4 in 1, and many in 19. Oocyst residuum absent. Sporocysts broadly ovoid. Stieda body absent. Twenty-eight sporocysts measured 14 to 18 by 8 to 11 μ (mean 15 by 10 μ). Sporocyst residuum present. Sporozoites lie head to tail in sporocysts. One large and one or two small clear globules usually present in each sporozoite.

FIG. 1. Sporulated oocyst of *Eimeria christenseni* (× 1,000).

The oocysts described above are similar to those originally described from the goat in Illinois, U.S.A., by Levine, Ivens and Fritz, 1962,[1] except that they are slightly larger. In addition, I also encountered a few ellipsoidal forms that resembled *Eimeria ahsata* in the general shape of the oocyst, but differed from it in the shape of the micropylar cap and the sporocyst, both being typical of *E. christenseni*. This lends support to the assumption of Levine, Ivens and Fritz (*loc. cit.*) that some of the earlier workers, *e.g.*, Rysavy (1954)[2] might have confused this species for *E. ahsata*.

This is apparently the first record of *E. christenseni* from India.

I am also beholden to Shri R. L. Kaushal, Principal of the College, for facilities provided.

College of Veterinary   HARISH L. SHAH.
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TWO NEW LEAF-SPOT FUNGI

DURING the months of October and November 1963 the authors came across many spotted leaves of *Chlorophytum* sp. and *Lilium* sp. growing in pots at the Alfred Park, University Botanical Garden, and other gardens of the town. On examination it was observed that *Chlorophytum* sp. was infected with a species of *Colletotrichum*, and *Lilium* sp. with a species of *Phoma*. So far no species of *Colletotrichum* has ever been reported on any species of *Chlorophytum*. A comparison of the morphological characters of the present isolate with those of other species of *Colletotrichum* indicated that in some respects it is similar to *C. graminicolum* (Ces.) Wilson, while in others it has similarity with *C. dematium* (Pers. ex Fr.) Grove. It, however, could not be accommodated in any of the known species and thus is presented here as a new species.

Three species of *Phoma* [*viz.*, *P. Picea* (P.) Sacc., *P. liliacerum* West. and *P. herbarum* West.] have been reported on different species of *Lilium*, but the present isolate was not similar to any of them. A new species is, therefore, created to accommodate the present isolate.

1. *Colletotrichum chlorophytumi* SP. N.

On living leaves of *Chlorophytum* sp., Alfred Park, Allahabad, October 1963, leg. S.C.

Symptoms of the Disease.—The disease starts in the form of small brownish spots on any part of the lamina, more commonly on its margin or tip (Fig. 1). The spots gradually elongate and cover an appreciable area of the leaf. On the basis of colour three zones may be distinguished in mature spots. Inner zone of deep slaty-brown colour, the middle limiting band of dark vinaceous-gray colour and peripheral zone of honey-yellow or light dull-green yellow. The inner zone in later stages bears few minute black fruiting bodies—acervuli, which are restricted to the upper surface only.

Morphological Characters.—Hyphæ slender, branched, colourless, septate, both inter and
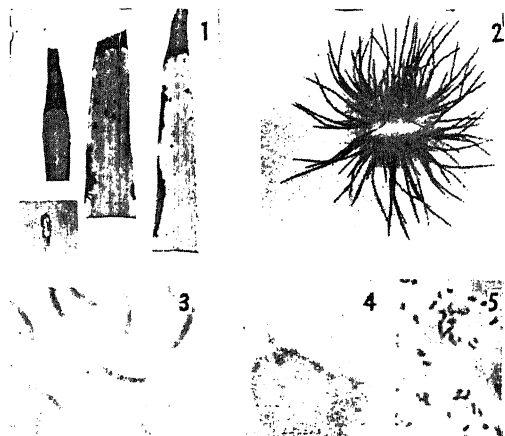
FIGS. 1-5. Fig. 1. Diseased leaves of *Chlorophytum* sp. Fig. 2. Acervulus of *Colletotrichum chlorophytumi*, × 40. Fig. 3. Curved conidia of *C. chlorophytumi*, × 400. Fig. 4. Pycnidium of *Phoma liliana*, × 40. Fig. 5. Spores of *P. liliana*, × 250

intracellular, acervuli superficial, light brown, oval or circular, 80·8–168·4 μ (average 134·2 μ), with few setæ scattered over the surface; setæ dark brown, thick-walled, unbranched, 2-3 septate, septa indistinct, with blunt apex, 70·4–142·8 μ (average 102·2 μ) in length and 5·2–6·4 μ (average 5·8 μ) in width; conidiophores simple, hyaline; conidia hyaline, curved, tapered at both ends, slightly truncate at base, wider nearer the base and tapering more gently towards the apex, 16·4–26·2 × 3·5 μ (average 20·4 × 3·1 μ). In culture acervuli round, 105·2–320 μ (average 210 μ) in diameter, with many setæ (Fig. 2); conidia curved, truncate at base but tapered sharply at the apex and not so much at the base, of even width along the greater part of the length (Fig. 3), 20·8–30·2 × 3·2–5·6 μ (average 24·2 × 4·1 μ) in size.

Latin Diagnosis.—Hyphæ, tenues, ramosæ, incoloræ, septatæ, intercellulares et intracellulares; acervuli superficiales, pallide brunnei, ovales vel circulares, 80·8–168·4 μ (mediet 134·2 μ), setis non nullis dispersis per superficiem; setæ fusce brunneæ, parietibus crassis, non-ramosæ 2-3 septatæ, septis indistinctis, apice hebete, 70·4–142·8 μ (mediet 102·2 μ) longæ, et 5·2–6·4 μ (mediet 5·8 μ) latæ; conidiophora simplicia, hyalina; conidia hydalina, curva, ad utrumque apicem fastigata, paulum truncata ad basin et latiora, fastigata plus molliter ad apicem 16·4–26·2 × 3·5 μ (mediet 20·4 × 3·1 μ).

In foliis viventibus *Chlorophyti* sp. in Alfred Park, ad Allahabad, mense octobri 1963, leg

S.C. Typus positus in CMI ad Hortum Kewensem sub numero IMI 103806.

2. Pr. *Phoma liliana* sp. n.

On living leaves of *Lilium* sp. University Botanical Garden, Allahabad University, November 1963, leg S.C.

Symptoms of Disease.—At first pale purplish vinaceous areas appear at the tip or margin of the leaves. With age the colour changes to pale-brownish-vinaceous and finally to pale grayish vinaceous. In severely infected leaves the healthy portion of the leaf is distinguishable from the diseased one due to the presence of a well-defined light russet vinaceous-coloured narrow band. The spread of the spot is more rapid in longitudinal direction although the midrib is freely traversed. The infected portion finally dries up and then very minute black fruiting bodies are seen on the surface of the lamina.

Morphological Characters.—Pycnidia mostly separate, globose, with a broad papilla and wide ostiole (Fig. 4), 205–425 μ (average 310 μ) in size, light brown to dark brown in colour, pycnidial wall consisting of two layers, outer plectenchymatous and inner parenchymatous : spores cylindrical or spherical (Fig. 5), 2–5 $\times$ 1·5–2·4 μ (average 3 $\times$ 1·5 μ). Hyphæ light brown, branched, septate, slightly constricted at septa, 2·5–6·4 μ in thickness ; chlamydospores spherical, 3·5–5·8 μ in diameter.

Latin Diagnosis.—Pycnidia vulgo separata, globosa, ornata pallide una et ostiolo lato 205–425 μ (mediet 310 μ), pallide brunnea vel fusce brunnea, parietibus constantibus serie duplici, exteriore quidem plectenchymatica, interiore vero parenchymatica ; sporæ cylindricæ vel sphæricæ, 2–5 $\times$ 1·5–2·4 μ (mediet 3 $\times$ 1·5 μ). Hyphæ pallide brunneæ, ramosæ, septatæ paulum constrictæ ad septa, 2·5–6·4 μ crassæ ; chlamydosporæ sphæricæ, 3·5-6·8 μ diam.

In foliis viventibus *Lilii* sp. in horto botanico universitatis ad Allahabad, mense novembri 1963, leg S.C. Typus positus in CMI sub numero IMI 105607.

The authors' thanks are due to Dr. J. C. F. Hopkins, and Mr. B. C. Sutton, C.M.I., Kew, England, for their help in identification, and to Rev. Fr. Prof. H. Santapau for Latin diagnoses.

Plant Pathological Lab.,   Sudhir Chandra.
Department of Botany,   R. N. Tandon.
Allahabad University,
March 4, 1965.

PRODUCTION OF PROTOPECTINASE BY *FUSARIUM VASINFECTUM*

Fusarium vasinfectum Atk., the cotton wilt pathogen, has been reported to secrete pectin methyl esterase (PME),[1,2] polygalacturonase (PG)[3] and cellulase (CS)[4] in culture media. The production of another important pectinolytic enzyme, protopectinase (PP) or the macerating enzyme[5] has not been studied in *F. vasinfectum*.

The fungus was cultured in 250 ml. Erlenmeyer flasks with 50 ml. of Richard's medium containing sucrose, citrus, pectin or carboxymethyl cellulose (Nutritional Biochemical Corporation, Cleveland, Ohio, U.S.A.) 2% w./v. as the carbon source and incubated for 3, 7, 15 and 30 days at room temperature (26–29° C.). At each interval, the mycelial mat was separated by filtration and the filtrate was centrifuged to obtain cell-free preparations. The pH of all the filtrates was adjusted to 6·5. 20 ml. portion of the filtrates were poured in 9 cm. sterile petri dishes and four potato medullary discs of 1 mm. thickness, 9 mm. diameter, were placed in each dish and the coherence of the tissues was tested with a glass rod at the end of 24 hr.[5] Uninoculated media, heated filtrates and water served as controls.

In the pectin medium the fungus produced PP, which could be detected on the 7th, 15th and 30th days, but not on the 3rd day, whereas the enzyme could not be detected in the medium with sucrose and carboxymethyl cellulose as carbon sources. Besides, the fungus also produced PME in the pectin medium only and PG and CS in the pectin, sucrose and carboxymethyl cellulose. The failure of the fungus to produce PP in media without pectin suggests the adaptive nature of the enzyme production. The importance of PP in the wilt syndrome of cotton plants requires to be investigated. A detailed account of the studies will be published elsewhere.

Microbiology Laboratory,   A. Mahadevan.
Faculty of Agriculture,
Annamalai University,
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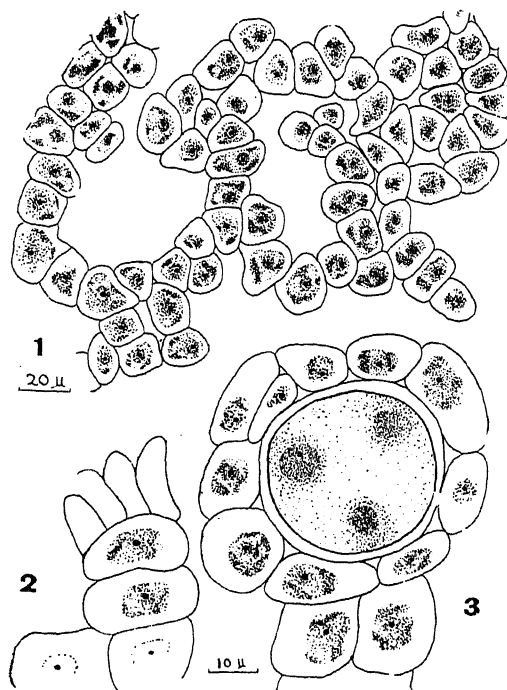# COLEOCHAETE NITELLARUM JOST.— A NEW ADDITION TO THE INDIAN FLORA

THE genus *Coleochœte* (Chlorophceæ) is known to be represented in the Indian algal flora by three species only, *viz.*, *C. scutata*, *C. soluta* and *C. orbicularis*.[1,2] Material of a fourth species, *C. nitellarum* Jost.,[3] was collected growing abundantly on *Chara wallichii* Braun in the Basaha lake in district Unnao (U.P.) during winter months. This species has not been recorded earlier from India. We give here a brief description of the Indian plant.

In most localities of the world where this species has been found, it grows endophytically within the cells of various species of *Chara* and *Nitella*. In the present collection, however, the alga has been found growing as an epiphyte on the outer surface of another alga, *Chara wallichii*. It was found growing submerged up to a depth of 2 feet on the fringes of the lake. The three other species of *Coleochœte*, known from India, were also growing associated with it in the same habit and habitat epiphytically on the same host.

The plant body consists of numerous irregularly branched prostrate filaments, creeping along the surface of the host plant. The filaments are composed of sub-rectangular or square polygonal cells. The filaments sometimes appear to coalesce laterally over short distances, although branching is mostly diverse and diffused (Fig. 1). Each cell contains a single plate-like chloroplast filling the greater part of the cell and containing usually a single central pyrenoid. There is a single nucleus in each cell occupying a somewhat eccentric position. The cells measure from 10.6 to $20.5\,\mu$ in breadth and 10.0 to $16.0\,\mu$ in length No bristles or setæ or their bases were seen.

Zoospores or other means of asexual reproduction were not found in the material. It, however, showed profuse sexual reproduction. The species is homothallic and antheridia and oogonia may be found even on the same branch of a filament. The antheridia are small-celled, usually sub-conical or stupose structures formed at the apices of filaments and are generally found in clusters (Fig. 2). Sometimes, they are also produced laterally on the filaments. The antherozoids are liberated through ruptures at the tips of their parent antheridia. No secondary proliferation of the antheridia was seen although empty antheridia were observed abundantly in the material. The oogonia appear to be formed terminally on the filaments. In many cases, oogonia were found in lateral positions on the filaments. The latter condition may be due to further vegetative growth from the sub-oogonial cell of the parent filament shifting the originally terminal oogonium to a lateral position. Each oogonium is about the same size or somewhat larger than the vegetative cells and possesses a slight beak-like anterior protuberance representing the trichogyne which contains only colourless cytoplasm. The lower inflated portion of the oogonium contains a single pale-coloured uninucleate egg.

FIGS. 1–3. *Coleochœte nitellarum* Jost. Fig. 1. A portion of branching vegetative filaments. Fig. 2. Apical portion of a filament bearing empty antheridia. Fig. 3. A Spermocarp

After fertilization, the oospore becomes thick-walled and fills the entire space within the oogonium; hence the wall of the oogonium is not clearly distinguishable from the wall of the oospore. The sub-oogonial cell and other vegetative cells in immediate vicinity of the oospore put forth short filaments which completely surround the maturing oospore and ultimately form the corticating investment forming the aggregated fruit-body or the spermocarp (Fig. 3).

Department of Botany,   BRAJ NANDAN PRASAD.
University of Lucknow,   P. N. SRIVASTAVA.
Lucknow, *March* 10, 1965.

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REVIEWS AND NOTICES OF BOOKS

Methods in Computational Physics. Edited by Berni Alder, Sidney Fernbach and Manuel Rotenberg. (Academic Press, New York and London).

Volume 1, 1963. Pp. xi + 304. Price $ 10.00.
Volume 2, 1963. Pp. xi + 271. Price $ 11.00.
Volume 3, 1964. Pp. xii + 386. Price $ 13.50.

The computer has become the laboratory tool of the theoretical scientist. With it he hopes to learn new things which were previously inaccessible, in very much the same way as an experimentalist employs a piece of equipment. This hope depends to a large extent on the development of new methods designed specifically for the computer. The major aim of this series of books is to collect these techniques which were developed in the solution of physical problems.

Volume 1 of this series contains the following contributions : The Numerical Theory of Neutron Transport, by Bengat G. Carlson ; The Calculation of Nonlinear Radiation Transport by a Monte Carlo Method, by Joseph A. Fleck, Jr. ; Critical-Size Calculations for Neutron Systems by The Monte Carlo Method, by Donald H. Davis ; A Monte Carlo Calculation of the Response of Gamma-Ray Scintillation Counters, by Clayton D. Zerby ; Monte Carlo Calculation of the Penetration and Diffusion of Fast Charged Particles, by Martin J. Berger ; Monte Carlo Methods Applied to Configurations of Flexible Polymer Molecules, by Frederick T. Wall, Stanley Windwer, and Paul J. Gans ; Monte Carlo Computations on the Ising Lattice, by L. D. Fosdick ; A Monte Carlo Solution of Percolation in the Cubic Crystal, by J. M. Hammersley.

Volume 2 of this series contains the following contributions : The Gaussian Function in Calculations of Statistical Mechanics and Quantum Mechanics, by Isaiah Shavitt ; Atomic Self-Consistent Field Calculations by the Expansion Method, by C. C. J. Roothaan and P. S. Bagus ; The Evaluation of Molecular Integrals by the Zeta-Function Expansion, by M. P. Barnett ; Integrals for Diatomic Molecular Calculations, by Fernando J. Corbato and Alfred C. Switendick ; Non-Separable Theory of Electron-Hydrogen Scattering, by A. Temkin and D. E. Hoover ; Estimating Convergence Rates of Variational Calculations, by Charles Schwartz.

Volume 3 of this series contains the following contributions : Two-Dimensional Lagrangian Hydrodynamic Difference Equations, by William D. Schulz ; Mixed Eulerian-Lagrangian Method, by R. M. Frank and R. B. Lazarus ; The Strip Code and the Jetting of Gas between Plates, by John G. Trulio ; Cell : A Time-Dependent, Two-Space-Dimensional, Coupled Eulerian-Lagrange Code, by W. F. Noh ; The Tensor Code, by G. Maenchen and S. Sack ; Calculation of Elastic-Plastic Flow, by Mark L. Wilkins ; Solution by Characteristics of the Equations of One-Dimensional Unsteady Flow, by N. E. Hoskin ; The Solution of Two-Dimensional Hydrodynamic Equations by the Method of Characteristics, by D. J. Richardson ; the Particle-in-Cell Computing Methods for Fluid Dynamics, by Francis H. Harlow ; the Time-Dependent Flow of an Incompressible Viscous Fluid, by Jacob Fromm. C. V. R.

Electron Paramagnetic Resonance. By S. A. Al'tshuler and B. M. Kozyrev. (Academic Press, New York and London), 1964. Pp. xi + 372. Price $ 13.50.

This book is a comprehensive treatise on the field of electron paramagnetic resonance, covering both the theoretical background and the results of experiment.

The text includes discussions of much Russian work which has never before been available in English, and exhaustive references to the original literature are provided after each chapter. Special emphasis is given to expositions of theoretical calculations and experimental data on ionic crystals. The extensive tabulation of experimental data and literature references on transition metal ions will prove a particularly useful feature. An index has been added to the original text, thus making it invaluable as a reference work. C. V. R.

Pulmonary Deposition and Retention of Inhaled Aerosols. By T. F. Hatch and P. Gross. (Academic Press, New York and London), 1964. Pp. xiv+192. Price : Cloth Bound $ 5.95 ; Paper Back $ 3.45.

This concise monograph on pulmonary deposition and retention of aerosols will be found highly useful by industrial hygienists, health physicists, microbiologists, industrial physicians

and medical specialists in radiation health, infectious diseases and air pollution.

The subject is dealt with in eight chapters whose titles are as follows : 1. Introduction ; 2. Anatomical and Physiological Factors in Respiratory Deposition of Aerosols ; 3. Physical Factors in Respiratory Deposition of Aerosols ; 4. Experimental Studies on Deposition of Inhaled Aerosols ; 5. Pulmonary Clearance ; 6. Experimental Studies on Pulmonary Clearance ; 7. Disease Risk from Inhaled Aerosols and 8. Measurement of Respirable Aerosol Exposure.

Over 200 references are cited, including the most recent publications.   C. V. R.

Optical Illusions. By S. Tolansky, F.R.S. (Pergamon Press, Hedington Hill Hall, Oxford), 1964. Pp. ix + 156. Price 35 *sh.* net.

The nineteenth century studies of geometrical optical illusions made by physicists and psychologists are revived in this book. The development of varieties of illusion is traced, and in particular it is established that simple geometrical illusions can lead to very false assessments of length, area, curvature, angle, parallelism and so on. Many new illusions are designed and basic general principles derived. Illusions, such as why the moon appears so large on the horizon, are clarified ; the moon in art is discussed and the associated illusory effects are analysed. This subject of illusions has been virtually neglected since 1900, when it was scientifically active, and this book revives and extends it in an original, instructive and entertaining manner.

All science students will benefit greatly from the realisation that optical illusions can confuse their assessments. The book will also be of interest to the artist and art student, the psychologist and student of psychology, the teacher and the layman. It is written at a non-technical level, making it suitable for those with no previous knowledge of this fascinating subject.   C. V. R.

Automation and the Future of Man. By S. Demczynski. (George Allen and Unwin. Ltd., Ruskin House, Museum Street, London), 1965. Pp. 238. Price 32 *sh.* net.

The physical dependence of man on his tools and the extent to which they condition his mental outlook, individually and collectively, is already very great and is certain to increase sharply with the further development of automation and automatic data processing. To examine critically this manifold interaction

between man and machine is the main purpose of this book. It contends that, in spite of spectacular technical achievements, modern Western civilization is basically empty and aimless and that, although we certainly can make some very complex machines, we are largely ignorant about applying them for the true benefit of mankind.

This might seem a rather unusual thesis for an author who is himself an industrial consultant with a scientific and technological background. However, his extensive interests outside his specialisation permit a humanistic view of the technical developments about which he can speak with professional authority. He is also helped by the fact that his background and his personal experiences have given him a first-hand knowledge of the worlds separated by the Iron Curtain. An ex-prisoner from a forced labour camp, his outlook is remarkably free from prejudice when facing a world full of fanatical ideologies, antirationalism and thermo-nuclear ballistic missiles. It is a book that may shock but cannot be ignored.

          C. V. R.

Nuclear Power Today and Tomorrow. By Kenneth Jay. (The English Language Book Society and Methuen and Co. Ltd., 36 Essex Street, Strand, London, W.C. 2), 1963. Pp. 270. Price 7 *sh.* 6 *d.*

This book is intended to give the laymen a better understanding of the nature of nuclear power and to explain some of the major problems which have to be overcome in making practical use of it. The book is concerned mainly with the different kinds of nuclear reactors ; their underlying principles are explained and illustrated by reference to particular plants or design studies. Interested readers will, I believe, find that the discussion of principles is full enough, and the range covered wide enough, to provide a broad view of the subject and a useful introduction to some of the more technical literature.

          C. V. R.

The Physiology of Diurnal Rhythms. By Janet E. Harker. (Cambridge University Press), 1964. Pp. vii + 114. Price $ 3.95.

This monograph surveys the properties of the biological clock which have been revealed by the study of the rhythmical processes under its control, and seeks to place these properties in perspective against the known physiological and biochemical processes of the living organism,

Some of the possible systems involved in the clock mechanism are discussed.

Particular attention is drawn to the remarkable influence which the clock has on the entire physiology of the animal, and to the physiological stress which may result from any upset of the orderly functioning of the timing system. The author's own studies have shown that gross upset of the timing system may result in the production of malignant tumours.

The subject is of wide current interest and will appeal to medical research workers as well as to botanists, zoologists, physiologists, experimental psychologists and people studying animal behaviour. C. V. R.

Vibration. By R. E. D. Bishop. (Cambridge University Press, Bentley House, 200 Euston Road, London, N.W. 1), 1965. Pp. 120. Price 30 *sh.* net ; Paper Edition also available. Price 21 *sh.* 6 *d.* net.

This book is based on the series of Christmas Lectures delivered at the Royal Institution, London, in 1962 to a predominantly young audience.

Vibration is a subject of great importance in many branches of mechanical engineering and the book is full of practical examples : these range from the swaying of overhead power lines and the oscillations of bridges, to flutter in aircraft and crack detection in metal forgings. The general principles of these often complex processes are brought out in a completely non-mathematical way, largely by descriptions and illustrations of the many experiments performed during the lectures. This introductory account of the mechanical engineer's approach to one aspect of his work will be useful to students beginning a study of Applied Mechanics and to anyone wanting to learn something of the sort of problems which professional engineers are called on to tackle. C. V. R.

The Evolution of the Metazoa. By Professor Jovan Hadzi. (Pergamon Press, Oxford, London, New York, Paris), 1963. Pp. xii + 299. Price £ 5 net.

This book is the result of many years of research in the Colenterata, and particularly in the Cnidaria.

After a critical application of the methods of comparative morphology, with special emphasis on the ontogenetics, and particular attention given to the ecological moments, and the consequences of the sessile way of life, the author has come to the conclusion that there exist neither true Colenterata nor any two-layered Metazoa, that the Cnidaria are not the most primitive Eumetazoa, and that we must rather consider the acoelous Turbellaria as the initial form for the evolution of the Eumetazoa. The consequence of this discovery is that we must try to find the origin of the Eumetazoa among the primitive Infusoria, and not among the colonial Flagellata. The author refuses to accept Taeckel's theory of blastææ and gastrææ, the theory of germ layers, of the origin of the mesoderm (mesophyl), of the metamerization, etc. The new interpretations proposed by the author require a radical reform of the natural animal system as a consequence of the new evaluation of the course of the phylogeny.

In presenting the result of many years of research the book does so in a manner which makes it of interest to the widest possible circle of zoologists and palæontologists.
C. V. R.

Penguin Science Surveys. Edited by A. Garratt (Section A) and S. A. Barnett and Anne McLaren (Section B). 1964, (A) 229 Pages, (B) 251 pages. 1965, (A) 296 pages, (B) 246 pages. Price 7 *sh.* 6 *d.* each section.

The *Penguin Science Surveys* endeavour to bring out in a compact manner recent research and developments in the fields of physical and natural sciences. The topics included touch upon various aspects of pure research and technology, together with contributions of general interest. Intelligent laymen will find the two publications of the series under review to be of great interest in view of the fact that they are enabled to keep track of latest developments in the scientific fields, without having to wade through a maze of mathematical formulæ. The contributors are distinguished men and they have all strived to write in a lucid style about extremely complex subjects.

The various articles appearing in Section A (1964) are : (1) Experimentation with Elementary Particles, (2) Nuclear Physics in Medicine, (3) The Optical Maser, (4) Adhesion, (5) Hydrology, (6) The Units and Standards of Measurement, in the Physical Sciences, (7) Communication by Satellite, (8) Soviet Space Research, (9) Automation, (10) How Discoveries are made : A Plea for Intuition, (11) Science and the Nation, (12) Television and the Teaching of Science, and (13) Some Chemical Tables.

Section B (1964) contains : (1) Life Beyond Tellus, (2) The Origin of Man, (3) The

Genetic Code, (4) Differentiation, (5) The Cause of Ageing, (6) Human Skin Colour, (7) Matters of Life and Death, (8) Anti-Bacterial Drugs, (9) Appetite and the Control of Body Weight, (10) Suicide, (11) Learning a Bird's Language, (12) Communication in Bees, (13) Biological Invasions, (14) Atmospheric Hazes : Whence, What and Whither, and (15) Communication or Jargon.

Section A (1965) includes articles on High field super-conductivity ; Surface structures of crystals ; Flash photolysis ; Physics of the Brain ; Automated spacecrafts ; Diamonds in industry ; Reaction dyes ; Rubber ; Communication of information.

Section B (1965) contains articles on Intelligence ; Stratagems for skill ; On drawing a diamond ; Machine intelligence ; Investigation of mental images ; Sleeping and Dreaming ; Homosexuality ; Tranquillizers and mental illness ; Yeasts of wine ; Penicillinase ; Lymphocytes, lymphoid tissue and immunity ; Leukæmia.   M. S. S.

International Review of Forestry Research (Vol. I). Editors : John A. Romberger and Peitsa Mikola. (Academic Press, Inc., New York and London), 1964. Pp. 404. Price $ 13.

Literature on Forestry Research is widespread and in many languages. There is a need for a serial publication of the type contemplated in this undertaking where fundamental topics in the broad field of forestry research can be critically reviewed and analyzed. As the editors point out in the Preface the approach will be academic with emphasis on basic biological principles.

The seven articles in this first volume of the series show clearly how this objective is being fulfilled. Each contribution is a review which brings together information from various sources. Three of the articles are of a general type. Kurt Mantel (Germany) writes on the "History of the International Science of Forestry with Special Consideration of Central Europe". Charles W. Ralston (Durham, N. Carolina) contributes an article on the "Evaluation of Forest Site Productivity". Another article is by A. D. Voute (Netherlands) on the "Harmonious Control of Forest Insects".

The swamp resources of the world, many hundred million hectares in area, have enormous potentialities for increased wood production. In many respects peat soil seems to offer better

conditions for intensive wood production of selected species of trees than do mineral soils. In the article on "Improvement of Forest Growth on Poorly Drained Peat Soils" Leo Heikurainen (Helsinki) discusses the utilization of swamps for forestry with special reference to amelioration of peat soils for forest growth by drainage and other silvicultural treatments.

Although climate and soil physical properties are the two major factors for forest growth, there are evidences to show that under some circumstances variations in soil nutrient supply may more than compensate for the effects of these two. This aspect of the problem is discussed by Carl Olof Tamm (Stockholm) in his article "Determination of Nutrient Requirements of Forest Stands". In a comprehensive review article on "Anatomy, Chemistry and Physiology of Bark" Lalit M. Srivastava (Massachusetts) pays particular attention to the developmental aspects of bark anatomy, extractives from bark, the concept of bark lignin, water relations of bark, seasonal changes in bark constituents, and the physiology of frost resistance. The last article is on "Physiological Processes in Forest Tree Seeds during Maturation, Storage and Germination" by Ken-ichi Hatano and Sumihiko Asakawa (Tokyo, Japan).   A. S. G.

Books Received

Fish as Food (Vol. 3)—*Processing* (Part I). Edited by G. Borgstrom (Academic Press, New York-10003), 1965. Pp. xiv + 489. Price $ 17.50.

Light Scattering from Dilute Polymer Solutions. Edited by D. McIntyre and F. Gornick. (Gordon and Breach, New York 11). Pp. xiv + 318. Price $ 5.95.

Elements of Finite Probability. By J. L. Hodges Jr. and E. L. Lehmann. (Holden-Day Inc., Sanfrancisco), 1965. Pp. 230. Price $ 5.20.

Fundamentals of Engineering Mechanics. By L. Levinson. (Gordon and Breach, New York-11), 1965. Pp. 333. Price $ 10.50.

Oriented Nuclei Polarized Targets and Beams. By J. M. Daniels. (Academic Press, New York), 1965. Pp. xii + 278. Price $ 9.00.

Nucleic Acids—Structure, Biosynthesis and Function. (Publications & Information Directorate, CSIR, Hillside Road, New Delhi-12), 1965. Pp. xi + 360. Price Rs. 20·00.

THE NEW PHYSIOLOGY OF VISION

Chapter XXVII. The Colours of Thin Films

Sir C. V. RAMAN

THE colours of interference formed one of the subjects discussed in the preceding chapter. But we return to the subject for the reason that the facts of observation to which attention was drawn in that chapter merit a more detailed exposition and discussion. It is a remarkable circumstance that though the colours of thin films have been the subject of study since even before the days of Sir Isaac Newton, an essential and indeed highly significant feature of these colours has remained unrecognised, viz., that the variations of colour exhibited by thin films are accompanied by variations of luminosity, these two effects standing in the closest relationship with each other. The facts which have now come to light are of great importance as they give a new orientation to the subject and incidentally also demonstrate that the colours of thin films cannot be understood or explained on the basis of the so-called trichromatic hypothesis.

Newton's Rings.—We begin by describing in detail the features of the interference pattern exhibited by an air-film enclosed between two plates of glass as seen by reflected light, the upper plate having a flat surface and the lower a convex surface with a large radius of curvature. Covering the rear of the second plate with black paint serves to give a dark background against which the pattern is more clearly seen. With the particular plates used in the study, the circular area covered by the pattern as seen by daylight has a diameter of a little over one centimetre. Held at the usual distance of distinct vision and viewed without any optical aid, the pattern appears as a dark circular area surrounded by five or six dark rings following each other at diminishing intervals. No colours are noticeable, the rings appearing as dark circles on a white field. The first two or three rings in the pattern appear much brighter than the field of uniform illumination surrounding the visible pattern. This effect is much less conspicuous in the case of the outer rings. The difference in brightness between the bright and dark rings which is highly conspicuous in the innermost rings, progressively diminishes in respect of those which follow. It is this factor, apart from the closeness

of rings, which limits the number which can be seen and counted.

Viewing the interferences at close quarters through a magnifying lens, the same features as those stated above are observed but now accompanied by striking manifestations of colour. Apart from the varying colours, maxima and minima of brightness in the pattern are conspicuously visible, the magnitude of their difference in brightness progressively diminishing as we proceed from the centre of the pattern outwards. Six successive minima can be seen and their positions in the pattern can be accurately located. Between each pair of minima and approximately midway between them appear the maxima of brightness. Beyond the sixth circle of minimum brightness, a few alternations of colour are noticeable but they are rather inconspicuous. The colours exhibited by the pattern are very clearly related to the variations of luminosity. Each colour sequence begins at a circle of minimum luminosity and is completed when the next minimum is reached. The colour sequence then starts afresh and proceeds till it is complete at the next circle of minimum luminosity. Six such colour cycles are noticeable, beyond which others may be glimpsed, but they are relatively inconspicuous.

For observing the colour-sequences and examining their features in detail, it is useful to employ a magnification higher than that which suffices for merely viewing the rings. The six colour-sequences visible in the pattern are all of the same general nature but differ in detail. Each sequence begins with a colour observable in the short-wave part of the spectrum and progresses towards greater wavelengths, finally ending up with a colour observable in the long-wave part of the spectrum. Each sequence of colour ends at a circle of minimum luminosity. There is then a sudden change of colour, and the sequence commences afresh and goes on to the next circle of minimum luminosity. The cycle then repeats itself.

The yellow of the spectrum is very conspicuous in the first bright ring of the pattern and appears along the circle of maximum luminosity in it. The yellow is also conspicuous in the

second bright ring, likewise appearing along the circle of maximum luminosity. The yellow is just noticeable in the third ring, appearing along the brightest circle. In the fourth, fifth and subsequent rings, we observe a change-over of the colour from a greenish-blue to an orange-red, but the yellow is not recognisable as such.

From the facts set forth above, it is evident that all the features exhibited by the interference pattern owe their origin to the dominant role played by the yellow sector of the spectrum in the visual perception of light and colour. Further, it is evident that the sharpness of the minima of illumination is analogous to the sharpness of the dark rings in interference patterns seen with monochromatic light. We infer that the visual receptor for yellow light has a sharply defined wavelength at which it is most effective. This wavelength permits of accurate determination by observations on the positions of the minima of illumination. The most convenient procedure for such determination is to view the interference pattern under a travelling microscope and after setting the spider line in the field of view on one of the minima of illumination to replace the source of white light by various different monochromatic light sources. Suitable for such comparisons is (a) the green light of a mercury lamp (5461 Å), (b) the yellow light of a mercury lamp (5770–5790 Å) and (c) the yellow of a sodium lamp (5890–5896 Å). It is then found that the green light of the mercury lamp has too small a wavelength and that the yellow light of the sodium lamp has too large a wavelength. But excellent coincidences are observed between the successive dark rings of the pattern as observed with the yellow light of the mercury lamp and the corresponding minima of illumination in the pattern as observed with white light. Since the mercury line 5770 Å exhibits a greenish-tinge while 5790 Å is a pure yellow, we choose the latter value. The observations thus enable us to place the peak absorption by the visual receptor in the retina as 579 mμ. This value agrees perfectly with the determinations by various other methods reported in earlier chapters.

The Colour Sequence in the Rings.—The recognition of the leading role played by the yellow sector of the spectrum in the perception of light and colour enables us also to explain the colour-sequences observed in Newton's rings in a very simple manner. The maxima of illumination in the pattern appear at the places

where light of wavelength 579 mμ is strongly reinforced, while the minima appear at the places where it is cancelled out by interference. Vivid colours can only appear in the regions where the yellow is weak, in other words, on either side of the minima of illumination. Light of wavelengths less than 579 mμ would determine the observed colour on the side which corresponds to greater path differences, since it is there that wavelengths greater than 579 mμ would cancel out by interference. *Vice-versa,* on the side where the path retardations are less, light of wavelengths of greater than 579 mμ would have the greater intensity and determine the observed colour. These statements correctly describe what is actually observed.

In the regions of the pattern corresponding to the thinner parts of the air-film, the bands of extinction in the spectrum of the reflected light which result from interference would necessarily be very broad. Hence, it is in these parts of the pattern that we may expect to observe colours corresponding to the extreme ends of the visible spectrum, *viz.,* deep blue on one side of the minima of illumination and deep red on the other side. When we move to the thicker regions of the air-film, the bands of extinction in the spectrum would be both narrower and more numerous. In such circumstances, the only colours which could manifest themselves are those of regions in the spectrum not too remote from the yellow sector, *viz.,* the bluish-green and the orange-red. This, again, agrees with what is actually observed.

A convenient arrangement for studying the interference colours of thin air-films is that described by the author in the preceding chapter. Besides being simple, the results obtained with it are very striking and beautiful. Instead of using lenses with curved and polished faces, we use two ordinary flat plates of glass. After careful cleansing, they are pressed into close contact. If the plates are not too thick or too large, they can be made to adhere firmly along all the edges and remain so permanently. A thin film of air is left enclosed between the plates and this exhibits interference colours when viewed by reflected light. It is useful to cover the outside of one of the two plates with black paint. This greatly improves the brilliancy of the colours. Thicker or larger plates of glass can also be successfully used. But it may then be necessary to clamp them together to prevent them coming apart.

The special advantage of using the device here described is that the colours appear extended over the area of the plate and are conspicuously visible without any optical aid. obtained with the yellow light of a sodium lamp ; Figure 1 (*b*) with the yellow lines of the mercury lamp isolated by a suitable colour filter. Figure 1 (*c*) was obtained with white light.
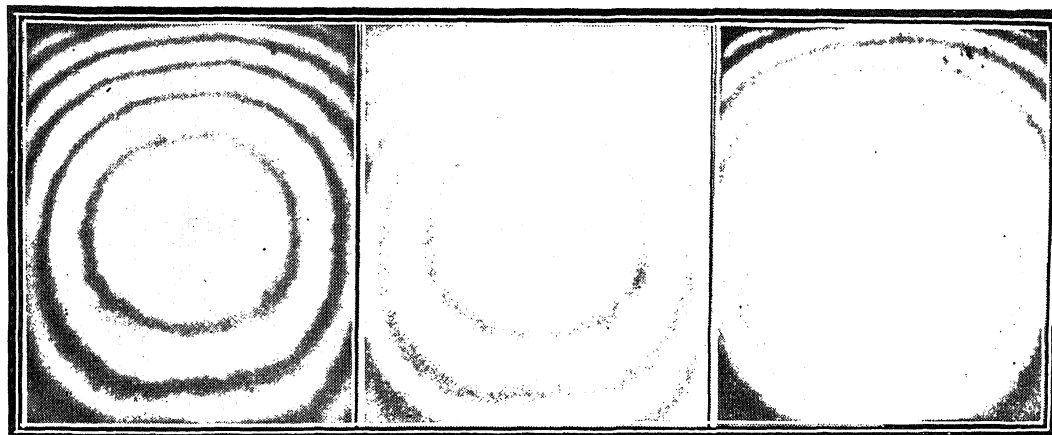
(*a*)   (*b*)   (*c*)

FIG. 1. Photographs of Interference Rings. (*a*) 589 mμ;   (*b*) 579 mμ;   (*c*) White light.

A further advantage is that the order of the interferences increases as we proceed inwards from the edges of the plate. It is frequently the case that the interferences form a set of closed curves, those of higher orders being enclosed within those of lower orders. The rings of higher orders instead of being crowded together are seen widely separated and thereby admit of being conveniently examined. The various features described and discussed earlier for the case of Newton's rings are also exhibited by these air-films in a very conspicuous fashion.

Figure 1 reproduced above illustrates the foregoing remarks. The three photographs were secured under identical conditions using panchromatic films except that the nature of illumination was different. Figure 1 (*a*) was

In each case, five minima of illumination appear in the pattern with the beginnings of a sixth minimum at the centre of the pattern. It will be seen that the change in wavelength from 589 mμ to 579 mμ results in a visible alteration of the pattern. In the third picture taken with white light, the dark rings which are the minima of illumination appear but there is a rapid falling off in the contrast between the minima and maxima. Thus the general nature of the effects as visually observed with white light is reproduced in the photograph. It will be noticed that there is a progressive diminution in the brightness of the maxima of illumination as we proceed to higher orders, this effect being accompanied by a diminution in the contrast between the maxima and the minima.

3

CARBOHYDRATE CONTENT IN THE SURFACE WATERS OF THE BAY OF BENGAL

R. THEODORE SRINIVASAGAM

Department of Zoology, University of Madras, Madurai Centre, Madurai-2

INTRODUCTION

OF the different organic constituents in sea-water, attention has been drawn only recently to the presence of substances in sea-water responding to analytical tests for carbohydrates. Even though Collier (1953) and Collier *et al.* (1950, 1953) detected these substances in the Gulf of Mexico in amounts up to 50 mg./l. and Wangersky (1952) isolated a dehydro-ascorbic acid in sea-water of the same area said to be present in inshore waters in concentrations reaching even 0·1 gm./l., it was the work of Lewis and Rakestraw (1955) who perfected the methods for quantitative estimation of the carbohydrates in sea-water which forms the basis of our knowledge regarding the distribution of carbohydrates in sea-water. The latter authors found that the mean dissolved carbohydrate content in the surface waters of the Pacific Ocean is 0·31 mg./l. while in the coastal lagoons it is found up to 7·9 mg./l. Recently Antia and Lee (1964) have determined "free" amino sugars in sea-water.

It is evident that more information is required not only regarding the quantities in which the dissolved carbohydrates are present in sea-water but also their distribution in the various seas. Further, very little is known about the distribution cf carbohydrates in the Indian seas. The cruises of the oceanographic vessel I.N.S. Kistna, taking part in the Indian programme of the International Indian Ocean Expedition was, hence, availed of for collection of water samples in the Bay of Bengal. The results of carbohydrate determination on these water samples are presented here.

METHOD

The surface sea-water was collected at eighteen stations during the VI and VII cruises of I.N.S. Kistna in the Bay of Bengal. Samples of water from the first twelve stations were collected in four-litre quantities and stored in large coloured bottles while water from the remaining stations were collected in 125 ml. reagent bottles. Mercuric chloride was added to the water soon after collection to give a concentration of 0·1 mg./l. to prevent bacterial action (Jeffrey and Hood, 1958). The water was analysed at various times after collection.

One portion of each water sample was filtered through a bacterial filter (Jenkins and Co., U.S.A.) which removed all particulate matter cf the size of bacteria. The method used by Dubois *et al.* (1956) for the estimation of total sugars was not sensitive enough to detect carbohydrates in sea-water. Instead, the method used by Lewis and Rakestraw (1955) was found to be suitable and anthrone was used in preference to N-ethyl carbazole. The optical density was measured at 627 μ using a S.P. 600 Unicam Spectrophotometer. Sucrose was used as a standard in the range from 0 to 10 mg./l. and appropriate dilutions were prepared at the same time when estimations on sea-water were made. A correction factor was applied to all readings to account for the increase due to the presence of chloride ion against the distilled water blank (Lewis and Rakestraw, 1955).

RESULTS

The results obtained are tabulated (Table I) along with the temperature, salinity and oxygen content of the surface waters at the time of collection. It may be observed that the carbohydrate content is higher in unfiltered water samples in contrast to sea-water filtered through a bacterial filter. The carbohydrate content in the unfiltered sea-water samples ranges from 1·1 mg./l. when taken away from the shore (Station 185—16° 30′ N., 86° 00′ E.: about 700 kilometres from Madras and about 380 kilometres from the nearest shore) to 6·9 mg./l. when collected from the inshore region near the Andaman Islands (Station 161—11° 41′ N., 93° 00′ E.; about 10 kilometres from Port Blair, Andamans). However, the same samples of water filtered through a bacterial filter show a carbohydrate content of 0·08 mg./l. and 0·53 mg./l. respectively. It is presumed that the values obtained for unfiltered water samples denote the carbohydrate content cf the dissolved as well as the particulate matter in the sea. However, the results obtained for the filtrates through the bacterial filter possibly indicate the amount of dissolved carbohydrates in sea-water.

TABLE I

Carbohydrate content in eighteen stations of Bay of Bengal

No.	Date and time of collection	Station	Location of the station		Temp. at the time of collection* (° C.)	Oxygen content* (ml. 1.)	Salinity * (‰)	Carbohydrate content (mg./l.)		Remarks
			Latitude	Longitude				Un filtered sea-water	Sea-water filtered through a bacterial filter	
1	23-2-1963 (0510 hr.)	147	08° 30′ N.	84° 20′ E.	27·1	3·86	34·14	3·1	0·10	..
2	24-2-1963 (0635 hr.)	150	08° 30′ N.	87° 02′ E.	28·5	4·03	33·98	3·8	0·15	..
3	25-2-1963 (0250 hr.)	153	08° 20′ N.	90° 00′ E.	27·7	4·14	33·37	3·1	0·30	..
4	26-2-1963 (0610 hr.)	156	09° 33′ N.	91° 53′ E.	27·9	3·90	33·01	2·7	0·31	..
5	26-2-1963 (2330 hr.)	158	09° 31′ N.	94° 00′ E.	27·3	4·04	32·84	6·5	0·30	..
6	27-2-1963 (1835 hr.)	160	10° 40′ N.	94° 48′ E.	27·3	4·13	32·75	5·3	0·12	..
7	2-3-1963 (1650 hr.)	161	11° 41′ N.	93° 00′ E.	27·6	3·93	39·90	6·9	0·59	Inshore region near Port Blair, Andaman Islands
8	5-3-1963 (0645 hr.)	163	11° 30′ N.	95° 00′ E.	27·8	4·05	31·10	5·5	0·23	..
9	5-3-1963 (0510 hr.)	169	15° 02′ N.	91° 58′ E.	26·9	3·70	31·72	4·4	0·10	..
10	6-3-1963 (0630 hr.)	173	14° 12′ N.	88° 41′ E.	27·6	4·19	32·45	2·1	0·14	..
11	7-3-1963 (1650 hr.)	177	13° 15′ N.	85° 01′ E.	28·2	4·17	34·47	2·4	0·08	..
12	8-3-1963 (1512 hr.)	180	13° 20′ N.	82° 00′ E.	28·4	3·99	33·62	2·6	0·12	..
13	14-3-1963 (1630 hr.)	182	14° 01′ N.	81° 00′ E.				1·4	0·09	..
14	15-3-1963 (0630 hr.)	183	18° 50′ N.	81° 56′ E.				1·2	0·12	..
15	15-3-1963 (2100 hr)	184	16° 30′ N.	83° 30′ E.				2·6	0·15	..
16	16-3-1963 (1345 hr.)	185	16° 30′ N.	86° 00′ E.		Data not available.		1·1	0·08	..
17	17-3-1963 (0230 hr.)	186	16° 30′ N.	88° 15′ E.				1·6	0·10	..
18	..	Madras	13° 40′ N.	80° 17′ E.				3·6	0·42	Inshore region near Madras
						Mean ..		3·3	0·19	
			Standard deviation for duplicate samples ..					±0·3	±0·07	

* Data obtained from the estimations on board the ship.

For easy reference the place of collection and the dissolved carbohydrates (value for water filtered through the bacterial filter) at that station are given in Fig. 1. It is of interest to note that the dissolved carbohydrates increase with the proximity to the shore. Thus, the highest values obtained are from water samples collected from the inshore regions of Madras (0·42 mg./l.) and Port Blair (0·59 mg./l.). On the other hand, in the off-shore regions it varies from 0·08 mg./l. to 0·31 mg./l.

REMARKS

The results reported by Lewis and Rakestraw (1955) seem to indicate that the amount of carbohydrates along the Pacific coast is also small. They found that while the dissolved carbohydrates varied from 0·16 to 0·45 mg./l.

(using anthrone) in the inshore regions, the unfiltered sea-water had a total carbohydrate content of less than 0·7 mg./l. in the open sea. As they obtained similar results from unfiltered

SUMMARY

The total as well as the dissolved carbohydrates in surface water samples collected from eighteen stations in the Bay of Bengal
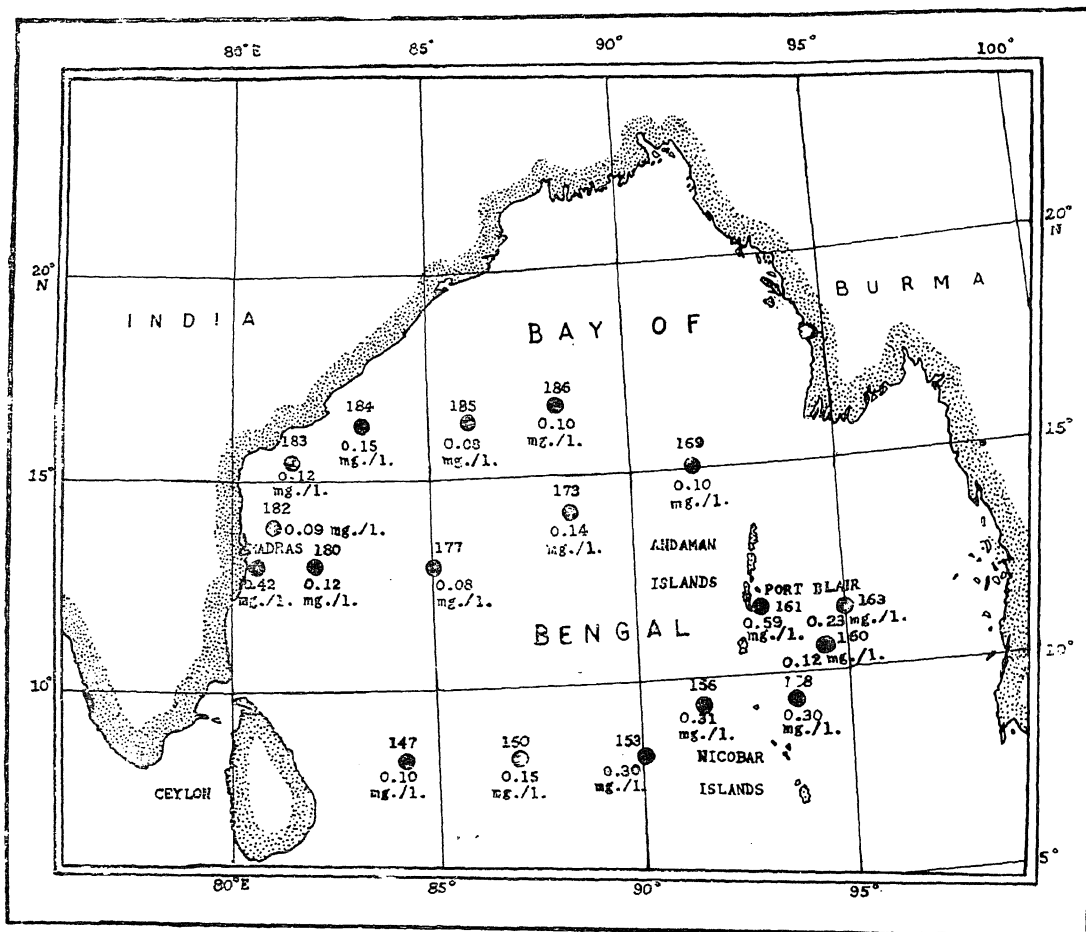

FIG. 1. Location of the stations with the amount of dissolved carbohydrates.

and filtered samples, they came to the conclusion that "the relative amount of such particulate material is small" at least along the Pacific Coast. It may be deduced from the results of the present investigation that the quantity of particulate material in the surface waters of the Bay of Bengal is considerable. However, there does not appear to be any concentration of carbohydrates in these waters as has been reported in the Gulf of Mexico by Collier (1953) and Collier et al. (1950, 1953) who detected them in amounts up to 50 mg./l.

It is proposed to continue the work when more samples are available.

were estimated. While the quantity of total carbohydrates ranges from 2·04 mg./l. to 6·9 mg./l. (mean: 3·3 mg./l.), the dissolved carbohydrates vary between 0·08 mg./l. and 0·59 mg./l. (mean: 0·19 mg./l.). Further, the carbohydrates dissolved in sea-water show an increasing concentration with the proximity to the shore.

thanks are due to Dr. N. K. Panikkar, Director, Indian Programme, International Indian Ocean Expedition, for permission to collect the water samples and his interest in this work. To Mr. C. B. Subramaniam of the Central Marine Fisheries Research Unit, Madras, and Mr. A. B. Wagh of the Institute of Science, Bombay, the author expresses his thanks for help in the collection of water samples. The receipt of a Senior Research Scholarship, Ministry of Scientific Research and Cultural Affairs, Government of India, is acknowledged.

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ISOLATION OF CHIKUNGUNYA VIRUS FROM *AEDES AEGYPTI* FED ON NATURALLY INFECTED HUMANS IN CALCUTTA

C. R. ANDERSON,[a] K. R. P. SINGH[b] AND J. K. SARKAR[c]

EPIDEMIOLOGICAL evidence and laboratory transmission studies have implicated *Aedes ægypti* as the principal vector of chikungunya virus in the recent epidemics in Calcutta.[1-4] It has been of interest therefore to determine whether humans circulating the virus could infect this species. For this purpose a colony of *Aedes ægypti* was established at the Calcutta School of Tropical Medicine from larvæ and pupæ collected from Calcutta City and nearby Howrah.

Unfortunately it was difficult to persuade people to allow themselves to be fed on by the mosquitoes. However, five individuals with fever and clinical symptoms similar to those associated with chikungunya virus infection gave permission. Since most arboviruses circulate during the earliest phase of the illness, and generally only for a relatively short period, it was necessary to feed the mosquitoes before the diagnosis was definitely established. In the present trials, virus was isolated from the blood of only three of the patients.

The first patient was an entomological technician who was presumably infected while collecting mosquitoes in localities where cases of chikungunya virus infection were occurring. He became ill on July 27, 1964. On July 29th, he was exposed to 40 *Aedes ægypti* and thirty-eight of them engorged. Chikungunya virus was isolated from a blood sample obtained at the time the mosquitoes were feeding, the titer of which was approximately 10^4 $LD_{50}/0.02$ ml. The mosquitoes were kept at room temperature until August 5th when they were allowed to feed on normal infant mice from the laboratory colony before shipment to the Poona headquarters of the Virus Research Centre.

During this interval 16 of the mosquitoes died but all of the remaining mosquitoes were successfully transported by air in closed wooden containers. After arriving in Poona, the mosquitoes were maintained in an environmental room at about 30° C. and 80% relative humidity. On August 11th, 13 days after feeding, each of a group of eight of the mosquitoes was allowed to feed on a separate two-day-old mouse but none of the mice became sick. Individual two-day-old mice were again exposed to the bite of several mosquitoes on August 17th and one of these became ill on the 4th day after the feeding. An agent was isolated from its brain which was identified as chikungunya virus by complement fixation test with known normal and hyperimmune sera. A third feeding was

made on August 25th of a group of 14 mosquitoes but none of the mice became ill. All of the mosquitoes found dead in the cage after arrival in Poona and those remaining alive after the August 25th feeding were stored at — 50° C. Most of these mosquitoes were tested individually, or in small groups, for the presence of virus. The mosquitoes were ground in a mortar and suspended in 1·5 ml. of bovine albumin phosphate saline containing 1,000 units of penicillin and 1 mg. of streptomycin per ml. Following light centrifugation to throw down the larger particles, the supernatant fluid of each suspension was inoculated in 0·02 ml. volumes intracerebrally into two groups of two-day-old mice. Chikungunya virus was isolated from a pool of two mosquitoes, one of which presumably fed on the mouse from which virus was isolated.

On September 24th, 1964, a hospital sweeper became ill and was admitted to the Carmichael Hospital of the School of Tropical Medicine, Calcutta. His temperature was 100·5° F. and he complained of severe bodyaches and joint pains. No rash was seen at that time. The patient was exposed to a group of 50 mosquitoes but only 20 became engorged. The titer of chikungunya virus in the blood of the patient at the time the mosquitoes fed was $10^{2 \cdot 8}$ LD$_{50}$/0·02 ml. Three mosquitoes died in Calcutta and were discarded. The engorged mosquitoes were transported in Barraud boxes in wooden containers to Poona by train and arrived on October 2, 1964. On arrival, 14 mosquitoes were found dead. These were ground in one pool and inoculated intracerebrally into infant mice. Chikungunya virus was isolated from this group of mice. On October 9th each of the remaining three mosquitoes was fed on a different two-day-old mouse. The mice did not become sick. A pool of the three mosquitoes was tested for the presence of virus by intracerebral inoculation of a suspension prepared from them into infant mice, but no virus was isolated.

Sixty-eight *Aedes ægypti* engorged on a third patient from whom chikungunya virus was isolated. In this case the blood sample obtained at the time the mosquitoes engorged had a titer of $10^{3 \cdot 5}$ LD$_{50}$/0·02 ml. The mortality among this group of mosquitoes was high and only 16 survived the trip to Poona. Unfortunately, the mosquitoes dead on arrival were not tested for virus. No virus was isolated from any of the remaining mosquitoes fed on this patient.

It has therefore been possible to demonstrate the infection of *Aedes ægypti* following engorgement on the blood of humans during the period of viremia. Although only two mosquitoes were shown to become infected, the titers of virus in the blood of these patients at the time the mosquitoes fed was not very high. The stage of the infection during which the titer of virus is highest is not known in chikungunya virus infection in man but much higher titers have been found in other patients during the course of the clinically apparent illness and one would expect that with higher titers a larger proportion of the mosquitoes would become infected after feeding.[5,6]

These results provide further evidence for the role of *Aedes ægypti* as an important vector of chikungunya virus and suggest that this virus might become established in a human population by person-to-person transfer by bites of *Aedes ægypti*. A city the size of Calcutta might very well be able to provide a sufficiently large susceptible population at all times to maintain chikungunya virus as an endemic infection.

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6. Virus Research Centre (Unpublished data).

LETTERS TO THE EDITOR

ELASTIC SCATTERING OF 1·12 MeV GAMMA-RAYS FROM PLATINUM AND TANTALUM

In an earlier communication[1] it was pointed out that the available experimental and theoretical data did not permit any reliable estimation of elastic scattering cross-sections from different elements at various gamma-ray energies and angles. It was suggested that our experimental results on Z-dependence when combined with the exact calculations of Brown and Mayers[2] for K-shell electrons in mercury should give a reliable estimate of the scattering cross-sections from different elements. In order to

The results obtained with the procedure outlined above are given in Table I. The experimental results are those of Narasimhamurty et al.[3] Also listed in the table are the values calculated from the form factor results of Franz.[4] Our estimated values are lower than those calculated by the form factor method given by Franz, but show better agreement with the experimental values at all angles except at 20° where the experimental values are lower; this may be due to the uncertainties involved in the measurement because of the difficulties encountered in the isloation of elastic scattering from inelastic scattering at this angle.[1]

TABLE I

Comparison of estimated and experimental values of elastic scattering cross-sections

Scattering angle (°)	Momentum transfer (q)	$(d\sigma/d\Omega)^{(80,q)}_{R+T}$	(n)	$(d\sigma/d\Omega)^{(z,q)}_{R+T} \times 10^{-26}$ cm.²/sr.					
				Platinum			Tantalum		
				Estimated	Franz (f. f.)	Experimental	Estimated	Franz (f. f.)	Experimental
20	0·76	7·1	3·3	6·50	6·30	5·50 ±0·82	5·2	5·17	4·51 ±0·67
30	1·13	1·82	4·2	1·64	1·83	1·29 ±0·20	1·25	1·51	1·09 ±0·17
45	1·68	0·26	4·8	0·23	0·506	0·157 ±0·023	0·17	0·417	0·127 ±0·019
60	2·19	0·05	5·05	0·047	0·202	0·0554±0·0084	0·036	0·166	0·0342±0·0051
90	3·1	0·022	5·2	0·0197	0·063	0·0180±0·0027	0·0143	0·044	0·0119±0·0018

demonstrate the applicability of the method we have estimated the values of the elastic scattering cross-sections of 1·12 MeV gamma-rays from platinum and tantalum at various angles and compared the estimated values with the available experimental and theoretical results.

The method of estimation consists in plotting the scattering amplitudes for mercury at different momentum transfers after taking into account the contributions of L-shell electrons and nuclear Thomson scattering. From such a plot it is possible to determine the value of elastic scattering cross-section for mercury at any energy and scattering angle. Making use of the experimental value of the index 'n' of Z-dependence as reported in reference 1 it is possible to calculate the elastic scattering cross-section for any element (Z ⩾ 47) from the relation,

$$(d\sigma/d\Omega)^{(Z,q)}_{R+T} = (d\sigma/d\Omega)^{(80,q)}_{R+T} \times (Z/80)^n$$

Physics Department,
Punjabi University,
Patiala, *June* 18, 1965.

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B. S. Sood.

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SYNTHESIS OF LANCEOLATIN-B

Lanceolatin-B(I) was isolated from the root bark of *Tephrosia lanceolata*[1] and was shown to be furano-(2′ : 3′ : 7 : 8)-flavone on the basis of degradative evidence by Rangaswami and Sastri.[2] Conversion of pongamol and norpongamol to lanceolatin-B was effected by Narayanaswami, Rangaswami and Seshadri[3] and Rao and Venkateswarlu[4] respectively.

Based on the idea that o-hydroxyphenylacetal-dehydes are the key intermediates in the formation of furano compounds in the biogenesis, Aneja, Mukerjee and Seshadri[5] worked out a method for building up of furan ring on oxygen heterocyclics. The synthesis of lanceolatin-B following the biogenetic pathway from 7-hydroxy flavone has now been achieved. Allylation of 7-hydroxy flavone, synthesised by the simplified Baker-Venkataraman transformation[6] and Claisen migration of the resulting allyl ether gave 7-hydroxy-8-allyl flavone.[7] Ozonolysis of this C-allyl flavone and decomposition of the ozonide by hydrogenation (Pd/C) afforded 7-hydroxy flavone-8-acetaldehyde. Ring closure of this compound by polyphosphoric acid gave lanceolatin-B, m.p. 148° (dried sample) identical with an authentic sample in all respects.
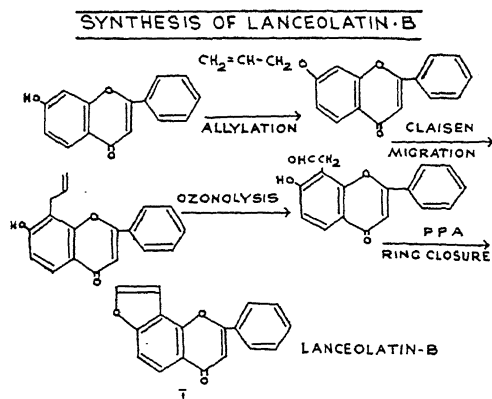
SYNTHESIS OF LANCEOLATIN-B

LANCEOLATIN-B

I

Department of Chemistry,   G. SRIMANNARAYANA.
Osmania University,   N. V. SUBBA RAO.
Hyderabad (A.P.), *September 6, 1965.*

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POTASSIUM THIOCARBONATE (PTC) AS A MASKING AGENT IN ANALYTICAL REACTIONS

PREVENTION of precipitation of any given ion or of its participation in any other reaction by combining it in a complex of a low degree of dissociation is known as masking. In recent years the technique of masking has been increasingly used[1-3] in analytical practice, as it makes the procedures expeditious. The interfering ions do not then require removal from test solutions.

PTC is already known as an effective sulphide[4-6] or thiocarbonate[7] precipitating agent. Its use as masking agent is based on its forming water-soluble thiocarbonate complexes with a number of metal ions: iron, cobalt, nickel, copper, molybdenum, vanadium and palladium. The complexes have characteristic colours, iron (dark red), nickel (blood red), copper (reddish-brown) and cobalt (brownish-green). Their stability depends on two factors: (i) *Solution pH*: As in similar cases, the thiocarbonate complex ions are decomposed by the action of H^+ ions. It is, therefore, necessary that in all the cases studied with PTC the pH must be sufficiently high to ensure masking. (ii) *Concentration*: Owing to mass action effects the use of high concentration of PTC is found to be necessary. The higher its concentration in solution, the lower is the degree of dissociation of the thiocarbonate complex.

Separation of Iron (II and III) from Metal Ions Forming Insoluble Hydroxides.—Titanium, beryllium and zirconium, when present with iron, have been quantitatively separated as hydroxides, while iron remains in solution due to its forming soluble thiocarbonate complex with PTC. Likewise extraction of arsenic, antimony and tin is achieved through their forming soluble thiocarbonate complexes: $K_3 [As^V (CS_3)_4]$, $K_3 [Sb^V (CS_3)_4]$ and $K_2 [Sn^{II} (CS_3)_2]$.

Identification and Determination of Thallium. —From alkaline solutions, thallium (I) has been quantitatively precipitated out with PTC in the presence of the above-noted metal ions that form soluble thiocarbonate complexes. Similar studies regarding cadmium, bismuth, lead, mercuric mercury, which remain insoluble in excess PTC, are in progress. Furthermore, in conjunction with EDTA the use of PTC of suitable strengths[8,9] ensures clean separation of metal ions due to 'cation generation technique' yielding granular or dense products. The detailed studies on such analytical separation of the metal ions will be published elsewhere.

The authors are thankful to Prof. T. R. Seshadri, F.R.S., for his keen interest. One of the authors (K. S.) is also grateful to C.S.I.R., New Delhi, for the award of a Fellowship.

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A NOTE ON THE FREE AMINO-ACIDS OF MALE AND FEMALE FLOWERS OF *CUCURBITA MAXIMA* (L.)

THE authors in a previous communication[1] reported the free amino-acid composition of the male and female flowers of diœcious plant *Carica papaya* (L). The present study is an extension of this work to the cucurbitaceous flower *Cucurbita maxima* (L).

The extraction of free amino-acids from the flowers, their identification by paper chromatography and a semi-quantitative assessment of the concentration of various amino-acids were done as reported earlier.[1]

The results indicate significant differences in the amino-acid composition of the male and female flowers of *Cucurbita maxima* (L.) both in quality and quantity. The male flowers contain 8 amino-acids (which include two indispensable amino-acids), namely Valine (+), Tyrosine (+), Glutamic acid (2 +), Threonine (+), Glycine (3 +), Serine (2 +), Aspartic acid (2 +) and Arginine (2 +). The female flowers contain 15 amino-acids of which 6 are indispensable amino-acids. They are Leucine (+), Isoleucine (+), Valine (2 +), Methionine (+), Tyrosine (2 +), Alanine (3 +), Glutamic acid (3 +), Threonine (trace), Glycine (+), Serine (2 +), Aspartic acid (4 +), Arginine (4 +), Histidine (+), Asparagine (+) and Lysine (+) (Each + indicates 2 mg./100 gm. wet weight of flowers).

It is interesting to note that in this plant as well as in *Carica papaya* (L.)[1] and *Coccinea indica* (L.)[2] asparagine is detectable only in female flower and the overall concentrations of aspartic acid and its amine are greater in the female than in the male flowers. The concentration of glutamic acid is greater in the female than in the male. Histidine and Lysine are present only in the female flowers and arginine is significantly in greater amounts in the female than in the male flowers. Thus, there seems to be a preferential accumulation of some acidic and basic amino-acids in the female flowers of cucurbita corroborating with the earlier findings in *Carica papaya* (L.)[1] There is however a difference in the composition of sulphur containing amino-acids (cystine and methionine) in cucurbita and cariea. While cystine is found to be present in both the flowers of *Carica papaya*, it could not be detected in the flowers of cucurbita whereas methionine is present in the female flowers of cucurbita while it could not be detected in both the flowers of *Carica papaya* (L). This needs further investigation.

Our thanks are due to Dr. J. Dasgupta, Reader in Biology, Medical College, Pondicherry, for his guidance and Dr. D. J. Reddy, Principal, for encouragement.

Biology Department,   S. KASINATHAN.
Jawaharlal Institute of   B. SRINIVASAN.
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AN INSTANCE OF *CHTHAMALUS* SURVIVING BELOW SAND LEVEL

WHILST collecting on the beach at Tranquebar, South India, recently an interesting case of barnacles surviving though buried in the sand was observed.

Tranquebar beach is a steep sandy surf-beach and the only solid substrata are masses of brickwork and sandstone boulders derived from the ruins of the old 17th century fort, the seaward face of which is now submerged due to encroachment of the sea. A large isolated block of sandstone was embedded in the beach sand except for a wedge-shaped area about 18" long and some 7" high at the upper end. This exposed area of rock carried a patch of living adult barnacles probably *Chthamalus challengeri* Hoek though the identification is not certain. The block was situated at about half-tide level and at the time of observation there was a

considerable force of water moving past it with the ebb and flow of successive waves. On attempting to clear the sand from the lower part of the block it was found that the patch of living *Chthamalus* extended below the sand surface. Further excavation in the intervals between waves revealed that the patch extended some 5″ below the level of the sand. These barnacles were all alive and readily opened the opercular valves as the water passed over them. There was no indication, such as the presence of dead organisms or staining of the rock, that the block had been moved by wave-action or otherwise since the settlement occurred.

With the inrush and especially the backwash of each wave the sand about the rock was stirred up to a depth of several inches. Between waves the sand settled to its normal level burying the barnacles. At low water, for a short time the barnacles were continuously buried in the sand.

The fact that all the barnacles in the buried part of the patch were alive and healthy indicates that they were able to breathe and feed satisfactorily although buried. Presumably during the backwash of the surf, the sand is sufficiently suspended to allow cirral activity to take place and for food to be obtained. Also the barnacles must be able to withstand the abrasive action of the sand grains driven by a considerable force of water and not suffer excessive damage to the cirri which might be expected under the circumstances.

Chthamalus challengeri occupies the highest animal zone on this shore and the patch of specimens discussed was situated near the upper limit for the species here.

Marine Biological Station,　　H. G. STUBBINGS.
Porto Novo, *September* 25, 1965.

EFFECT OF BARBITAL SODIUM ON MALE REPRODUCTIVE ORGANS OF ALBINO RATS

ADMINISTRATION of barbiturates reduces the adrenocortical secretions in rats, dogs and monkeys.[1-5] Suzuki *et al.*[4] suggest that barbiturates inhibit the secretion or release of adrenocorticotropins (ACTH) from the pituitary, thereby depressing the secretions of adrenals and their action is mediated through hypothalamus. Therefore it may be possible that barbiturates, being sedatives, may inhibit the secretions of gonadotropins and other hormones of the pituitary. However, very little is known regarding their effect on reproductive physiology except for the fact that they inhibit ovulation in rats when given at critical ovulatory period.[6-8] The present investigation is to study the effect of barbital sodium on male reproductory system in albino rats.

Adult albino rats of an inbred Wistar strain (CFTRI) weighing 80 to 90 gm. (40 days old) were used. They were maintained in the laboratory on CFTRI rat feed and water *ad lib* at a room temperature of $26 \pm 1°$ C. Barbital sodium, (Sodium 5, 5-diethyl barbiturate, Merck), in a dose of 15 mg./100gm. body weight in 1 ml. of distilled water, was administered subcutaneously twice a day for 20 days and the animals were autopsied without anæsthesia on 21st day. The controls received 1 ml. of distilled water. Testes, epididymis, vas deferens, seminal vesicle, ventral prostate, adrenal and thymus were dissected out, weighed to the nearest mg., fixed in Bouin's fluid, sectioned at 10μ thick and stained in Harris' hæmatoxylin-eosin, Heidenhain's iron hæmatoxylin and Mallory's triple stains.

Barbital sodium treatment affects the structure of the testis, but not its weight. In the controls, the seminiferous tubules are large, and closely packed with many sperms in their lumen. The seminiferous epithelium exhibits various stages of meiosis and spermiosis (Figs. 1 and 2) . In the barbital sodium-treated animals, the seminiferous tubules shrink considerably and are lined by highly vacuolated degenerating seminiferous epithelium with pycnotic nuclei (Figs. 3 and 4). The sperms are still present in their lumen. The intertubular spaces are wide with well-developed Leydig cells. In the barbital sodium-treated rats, there is significant increase $(P = < \cdot 01)$ in the weights of seminal vesicles and ventral prostate. There is no change in the weight of adrenals, but the thymic weight is reduced, probably due to increased secretion of androgens by the Leydig cells (Table I).

Barbiturates inhibit the secretions of the adrenal cortex and their action is probably mediated through hypothalamico-pituitary adrenal axis.[1-5] But administration of ether, morphine or urethane increases the secretions of adrenal cortex.[2] Everett *et al.*,[6] Everett and Sawyer[7] and Strauss and Meyer[8] have observed that barbiturates, when administered at a critical period, inhibit ovulation in rats. In the present experiment, barbital sodium treatment. which causes degeneration of seminiferous epithelium of the testis without affecting the Leydig cells or the accessory organs, indicates that it may inhibit the secretion or release of

<div align="center">TABLE I</div>

Effect of barbital sodium on male reproductory organs of albino rats

Treatment	Initial B.W. (gm.)	Final B.W. (gm.)	Organ weights (mg.)/100 gm. body weight (M±S.E.)						
			Testes	Epididym's	Vas deferens	Seminal vesicle	Ventral prostate	Adrenals	Thymus
Control (10) ..	83·8 ±2·3	142·6 ±1·7	950·0 ±50·0	114·5 ±18·5	33·5 ±4·5	31·5 ±7·5	27·0 ±8·0	26·0 ±1·3	190·0 ±15·0
Barbital sodium treatment (15)	80·6 ±1·4	132·8 ±1·8	1080·0 ±53·8	158·0 ±15·7	49·7 ±1·6	97·7* ±19·3	62·7* ±10·8	25·3 ±1·4	106·3 ±13·5

<div align="center">Number in parenthesis = Number of rats.   M±S.E. = Arithmetic mean ± standard error.
B.W. = Body weight.   Probability (P) = < ·01.</div>
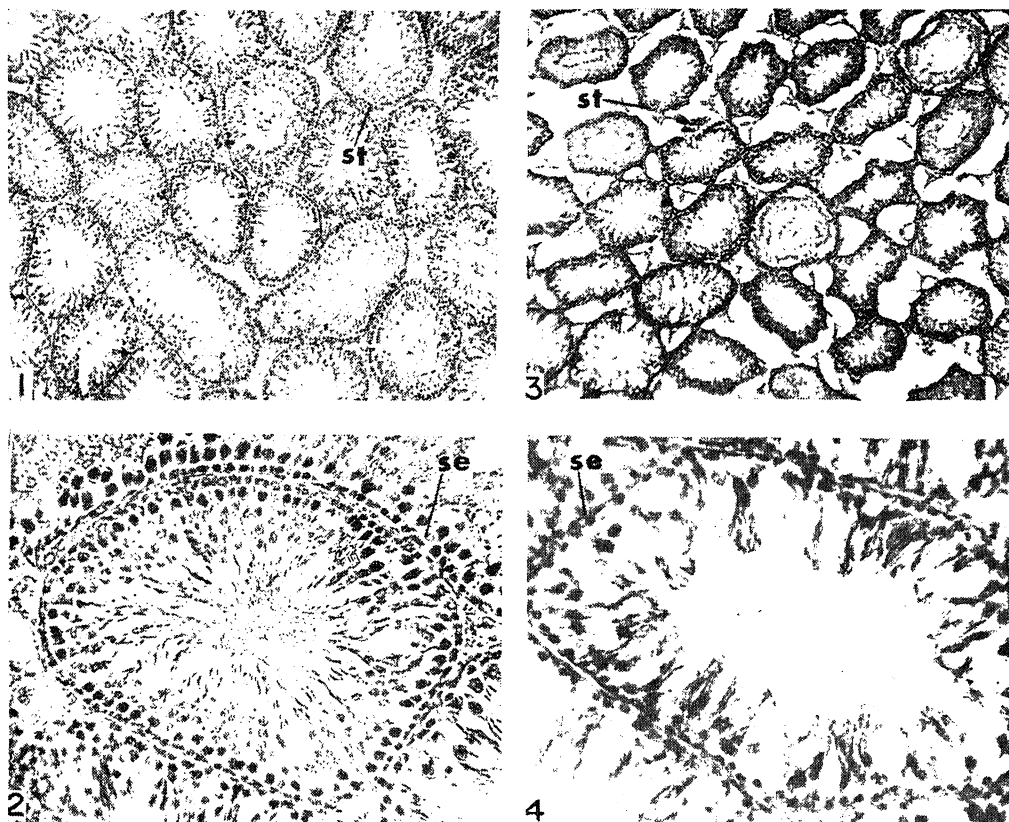
FIGS 1-4.   Fig. 1.   T.S. of the testis of control rat showing compact seminiferous tubules, × 50. Fig. 2.   A portion of Fig. 1 enlarged, showing a normal seminiferous epithelium, × 230.   Fig. 3.   T.S. of the testis of barbital sodium treated rat showing the shrinkage of seminiferous tubules, 50.   Fig. 4.   A portion of Fig. 3 enlarged showing the degenerated seminiferous epithelium, × 230.   (*Se*, Seminiferous epithelium ; *St*, Seminiferous tubule.)

gonadotropins, particularly Follicular stimulating hormone, from the pituitary.   The direct toxic effect of this drug on the testis seems improbable as it does not affect the Leydig cells or the accessory organs : However, it has to be tested by *vitro* experiments.

Continued barbital sodium treatment reduces the sleeping time gradually.   There is, however, no visible effect on the body weight or the intake of food.

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indebted. Our thanks are due to C.F.T.R.I. for the supply of rats, to R. Raju, for taking photomicrographs and to the University of Mysore for the research facilities.

Reproductive   MALATHI E. A. D'SOUZA.
Physiology Wing,   M. APPASWAMY RAO.
Department of Zoology,
Manasa Gangothri,
Mysore, *June 28, 1965*.

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FREE PROPIONIC ACID IN THE SKELETAL MUSCLE OF ELASMOBRANCHS

DURING a study of the quality of fish landed at Cochin the volatile acid number (VAN) was determined among other chemical indices of spoilage, in several fishes and crustaceans. While the VAN of the muscle in the fresh fish was not more than 4 in the teleosts and crustaceans, in the elasmobranchs it ranged from 14 to 22 (unpublished observation, Velankar *et al.*). A qualitative examination for the presence of free volatile fatty acids in elasmobranchs, teleosts and crustaceans was therefore carried out employing the paper chromatographic technique described by Kennedy and Barker.[1] Several species of fishes and crustaceans were examined during this study.

The elasmobranchs produced a spot corresponding to that of propionic acid run simultaneously on the chromatogram while none of the teleosts and crustaceans produced any spot. The presence of free propionic acid in the muscle of fresh elasmobranchs explains the observed higher VAN values for these fishes. Differences exist in the chemical composition of elasmobranchs and teleosts respectively particularly in respect of the urea and tri-methylamineoxide contents of the muscle, both being much higher in the former. Presence of free propionic acid in the elasmobranchs appears to be an additional difference in the two groups of fishes. The origin and role, if any, of the propionic acid in elasmobranchs might perhaps have a significance from the aspect of comparative physiology of fishes. From the technological aspect the presence of free propionic acid in elasmobranchs is important; for, in the application of the VAN determination as a quality index for these fishes, appropriately higher range of VAN values for the elasmobranchs, as compared with the teleosts and crustaceans, becomes necessary.

The technical assistance rendered by R. H. Pandit, Laboratory Assistant, is acknowledged.

Central Institute of   N. K. VELANKAR.
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Bombay-9, *May 24, 1965*.

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ISOPARORCHID INFECTION IN SOME HITHERTO UNRECORDED FISH SPECIES

Isoparorchis trisimilitubis Southwell, 1913 [Syn. *I. hypselobagri* (Billet, 1898); *Leptolecithum eurytremum* Kobayasi, 1921; Isoparorchidæ Poche, 1925], in its immature and adult forms, is parasitic in a large number of our freshwater fishes. Its occurrence from India, Japan, Australia, Java and China has been reported.[1-6] *Wallagonia attu, Barbus tor, Ophiocephalus striatus, O. marulius, O. punctatus, O. gachua, Gobius giuris, Notopterus notopterus, Mastacembelus armatus* and *Ambassis nama* are so far known as its hosts. The immature forms, in the musculature and internal organs and associated with the "inkspot disease", are in fact its metacercarial stage which in *B. tor, O. striatus, O. marulius, O. punctatus, O. gachua, G. giuris, N. notopterus* and *M. armatus* occur in muscle, mesentery, body cavity and liver.

During investigations on the common helminthic infestations of fresh-water fishes, *Belone cancilla, Mystus seenghala, M. vittatus* and *Eutropiichthys vacha* were found to act as additional hosts and a large number of specimens, in different stages of development, were collected from the abdominal and lateral muscles, as also from the body cavity. *M. vittatus* yielded immature stages from lateral musculature and in *E. vacha* juveniles were encountered in the body cavity, mesentery and liver. In addition to the known location—the musculature, *M. armatus* yielded specimens

from the body cavity, liver and mesentery and in *Mystus seenghala* the juveniles were recovered from the musculature and the adults from its gas bladder. Thus, *M. seenghala* is another species for the adult stage, the two others being *W. attu* and *A. nama*.

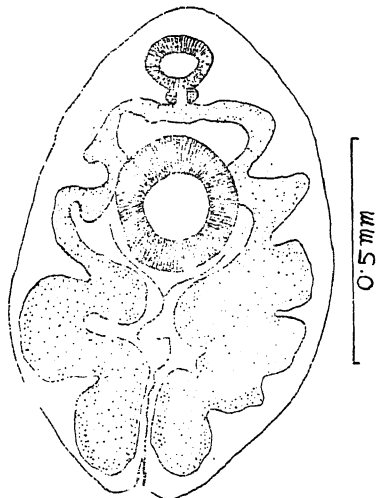Among the juveniles, from muscles in our collection, the youngest specimen (Fig. 1)

FIG. 1. Stained permanent mount of the youngest specimen, from muscle of *M. vittatus*.

(mounted and from *M. vittatus*) measured 1·07 mm. in length and 0·7 mm. in maximum breadth, with the subterminal oral sucker of 0·15 × 0·11 mm. in size, pharynx 0·08 × 0·9 mm. in size, wavy intestinal cæca extending to posterior extremity and well-developed acetabulum 0·43 mm. in diameter. Another young stage, with rudiments of testes, hermaphrodite sac and ovary (mounted and from *O. punctatus*) measured 2·01 mm. in length and 1·05 mm. in maximum breadth, with oral sucker of 0·35 × 0·26 mm., pharynx 0·12 × 0·16 mm. in size and acetabulum 0·52 mm. in diameter.

Numerous specimens, in intergrading series, were collected from muscles, mesentery and body cavity. Around the juveniles, the characteristic pigment masses in different sizes and dendritic in character were evident with the juvenile form lying coiled but with no evidence of any encapsulation—the pigment lying dispersed in the intermuscular spaces. In one of two specimens, found on the visceral side of the liver, a distinct fibrous capsule with pigment masses in the inter-fibrillar spaces had formed. The gas bladder, in *W. attu*, yielded both adults and immature forms but in varying grades of

development, the latter similar to those occurring in muscles and other locations. An immature form, collected once from its intestine, was 4·56 mm. long and 1·31 mm. in maximum breadth, with the oral sucker of 0·40 × 0·35 mm. and pharynx 0·20 × 0·22 mm. size and the acetabulum of 0·52 mm. in diameter. The adult specimens, available from the gas bladder of *W. attu* and *M. seenghala*, fully conform to the available description.
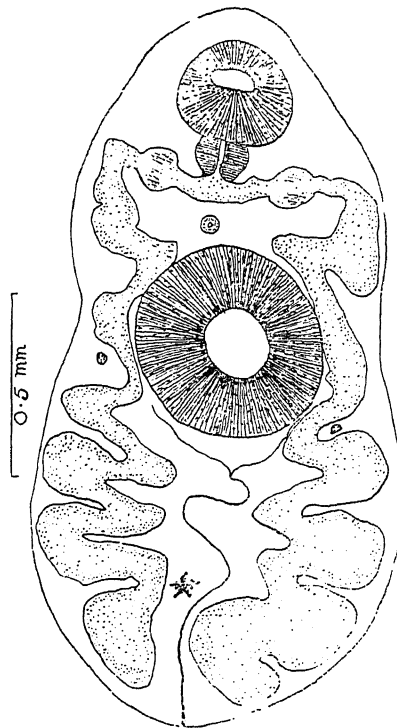

FIG. 2. Stained permanent mount of another young form, from muscle of *O. punctatus*.

The present finding, in enlarging the range of the known host list, adds four more species— *B. cancilla*, *M. seenghala*, *M. vittatus* and *E. vacha* and records the earlier developmental stages, both in intestine and gas bladder, from *W. attu* in which the nature of infection would depend on the state of the development of the juvenile form ingested and the length of infection. Further, *M. armatus* and *E. vacha* yielded immature forms in mesentery, body cavity and liver. It is probable that intensive search may show a greater incidence of this fluke which, when involving carps and other important species in the endemic areas, would be significant particularly from invasion of the musculature by the juveniles. Detailed work on life-history with a view to ascertain the ways the

definitive host, in which adults occur in gas bladder, spreads infection to the various fishes that suffer from the damage caused by juveniles is emphasized.

Thanks are due to the Principal of the College for the facilities provided.

Department of Parasitology,   P. RAI.
U.P. College of Veterinary   B. P. PANDE.
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INDELIBLE CLUES TO STOMATAL DEVELOPMENT IN MATURE EPIDERMIS OF PLANTS—II

IN my studies of the development and structure of stomata in diverse pteridophytes, gymnosperms, and dicots belonging to numerous primitive as well as advanced families I have frequently encountered groups of cells in the mature epidermis which look like arrested stomatal developments.

In their general appearance, the cell groups resemble the various developmental stages of the stomatal types found in the respective plants. In plants with mesoperigenous[1] type of development, *e.g.*, the Caryophyllaceæ, Onagranceæ, Ranunculaceæ and others, these groups consist of two unequal cells, a flat cell and a smaller triangular cell by its side. In plants whose stomata have two mesogene[2] subsidiaries, *e.g.*, Magnoliaceæ, Convolvulaceæ, Rubinaceæ, Acanthaceae and others, the groups consist of rows of two, three or more cells with their long axes parallel to each other (Figs. 1, 2). Often one of the mesarch elements in these rows is biconvex. In plants with diacytic stomata, *e.g.*, Asteracantha,[3] this biconvex cell is frequently elongated at right angles to the long axes of its lateral cells. In plants which have anisocytic stomata, *e.g.*, some Convolvulaceæ, Crassulaceæ, Compositæ the cell groups show one of the following three arrangements : (*i*) the groups consist of two unequal cells as in plants with mesoperigenous stomatal developments, (*ii*) the group has three cells, a central triangular cell wedged in between two unequal flat cells (Fig. 3), or (*iii*) the group has a central triangular cell

whose sides are flanked by three or more unequal cells (Figs. 4, 5). In plants with perigenous[1] stomata, *e.g.*, Agathis loranthifolia they show in the centre one cell (arrested meristemoid) or two (arrested guard cells which have not formed the intervening pore and assumed the characteristic shape) and these are surrounded by rings of cells looking like its perigene subsidiary and encircling cells (Figs. 6, 7).
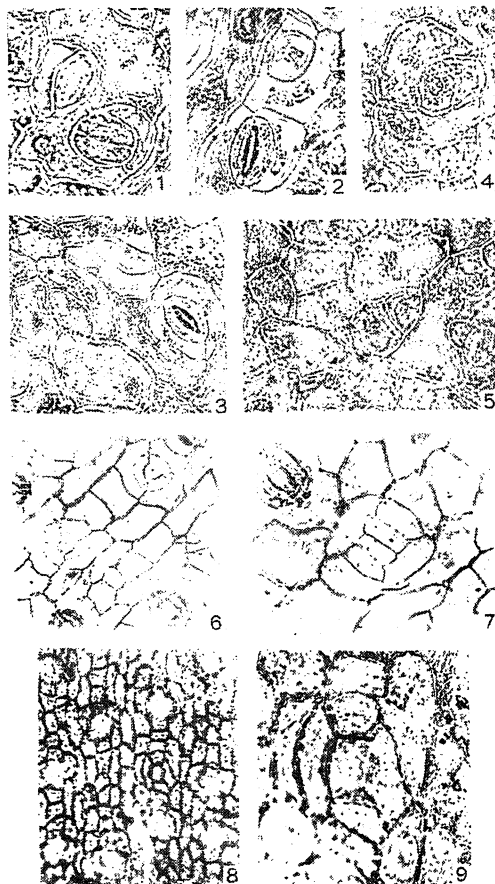
FIGS. 1-9. Figs. 1-5. Portions of lower epidermis of mature leaves showing arrested developments of stomatal meristemoids; Figs. 1-3. *E olmulus alsinides* Linn.; Figs. 4-5. *Bryophyllum* sp; Figs. 6-7. *Agathis loranthifolia* Salisb.—The structure in Fig. 7 has been arrested after the formation of the guard cells. Fig. 1, × 318; Figs. 2-4. × 587; Fig. 5, × 180; Fig. 6, × 133; Fig. 7. × 219. Figs. 8-9. *Desmiophyllum indicum* Sahni. Fig. 8. Portion of the cuticle of a compressed leaf from Jabalpur series (Jurassic) showing arrested stomatal meristemoids, × 56. Fig. 9. One of the arrested developments in Fig. 8 more magnified, × 214.

Numerous previous authors have also figured similar cell groups but have not realized their significance. The only previous report of such

cell groups is by Pant and Kidwai[4] who found them in the mature epidermic of leaves of *Phyla nodiflora*. As these authors have also pointed out, these groups look like persistent developmental stages of stomatal meristemoids where one or more divisions leading to the formation of the guard cells have been checked. Possibly the initials of these groups belong to a belated generation of stomatal meristemoids whose normal development is cut short because the overpowering tide of leaf-maturation overtakes them in infancy and they are perforce turned into ordinary epidermal cells. As a result they enlarge but fail to divide.

The occurrence of these cell groups is of more than ordinary significance because they form indelible clues and, in any case, confirmatory evidence about the mode of stomatal development in the mature epidermis. They are specially valuable for knowing the development of stomata in plants where developing material is not available and where divisions and modifications in size and shape of surrounding cells tend to obscure the typical arrangement which indicates their development. As these arrested stomatal developments remain unaltered in the mature epidermis of plants, I felt that they should exist in the cuticles of at least some fossil plants as well. Accordingly, I looked for them in the cuticles of fossil leaves, presently under investigation in my laboratory, and I have recently succeeded in locating numerous undoubted arrested stomatal developments in the cuticle of *Desmiophyllum indicum* (Figs. 8, 9) and other fossil leaves. It is thus likely that a search for similar cell groups in cuticles of the Bennettiales may furnish confirmatory evidence about the mesogene nature of their subsidiary cells. This is particularly important because the similar looking subsidiaries in the paracytic stomata of Gramineæ and other monocots are perigene.

A pair of cells seen on the left side in a photograph of a Bennettitalean cuticle figured in Pl. X, Fig. 8 by Lundblad[5] seemingly confirms the mesogenous derivation of its subsidiary cells. My experience with the epidermis of living plants shows that another evidence of the mesogene character of the subsidiaries in Bennettitalean stomata could be the intersection of their subsidiary cell walls in the region of both the stomatal poles.

Department of Botany,   DIVYA DARSHAN PANT.
The University, Allahabad (India),
March 19, 1965.

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DISTRIBUTION OF SOME PLANTS ALONG MIDNAPUR COAST IN WEST BENGAL STATE

WHILE studying the ecology of Midnapur coast of West Bengal State *Aeluropus lagopoides* and *Drosera burmanni* were collected near the coast, of which the former taxon is a new record and the latter an extension of its known distribution in the State.

Aeluropus lagopoides (L.) Trin. ex Thw. Enum. Pl. Zeyl., 374, 1864 ; Bor, *The Grasses of Burma, Ceylon, India and Pakistan*, 380, 1960. *Dactylis lagopoides* Linn. Mant., 33, 1767 ; *Aeluropus villosus* Trin. ex. C. A. Mey., Verz. Pfl. Cauc., 18, 1831 ; Hook. f. in Fl. Brit. India, 7 : 334, 1897.

This perennial grass is characteristic of saline depressions, flats and ridges of high soil moisture and good drainage. It spreads by stolons which radiate in all directions. Sometimes it roots at nodes and erect branched culms arise in tufts or singly (Fig. 1). The occurrence of this grass in a vacant ecological niche is significant for few other plants grow in such places. Occasionally, *Eleocharis geniculata* (L.) R. & S. and *Sessuvium portulacastrum* L. are found as associate species. In coastal areas of Saurashtra (Rao *et al.* 1965 a, b, c) this plant is sometimes found in association with *Fimbristylis cymosa* L., *Urochondra setulosa* L., *Suæda nudiflora* Moq., and *Sporobolus tremulus* L. This grass grows in light grey to grey sandy soils of fine texture where the salt content reaches to a maximum of nearly 0·4%. The pH indicates (7·8 to 8·0) a mild to moderate alkaline reaction. The organic contents are comparatively higher due to leaching and partial contribution by the plant itself. Sometimes total dissolved solids and sodium chloride contents are high due to innudation and saturation of the soil with sea-water. The soil is mildly calcareous with a calcium carbonate content ranging from 3·15 to 4%.

Distribution.—This species is reported to occur near the seacoasts of Sind (Blatter *et al.*, 1929), Saurashtra and neighbouring islands (Rao *et al.*, 1965 a, b, c), Bombay (Cooke, 1908),

Madras, near Nellore (Gamble, 1935), Ramesh-waram and Krusadi islands (Rao *et al.*, 1963 *a, b*) and in inland saline areas of Punjab, Marwar, Baluchistan and Afghanistan (Bor, 1942) extending up to the Mediterranean region and North-East Africa. The occurrence of this plant in West Bengal coast in Junput/Biramput, a coastal village 8 km. away from Contai Town, is of considerable interest because Bor (1942, p. 296) states, "Oddly enough, it has never been reported from the coasts of Orissa, Bengal or Burma"; recently he has again stated (1960, p. 296) "and also not been reported from the Bay of Bengal".
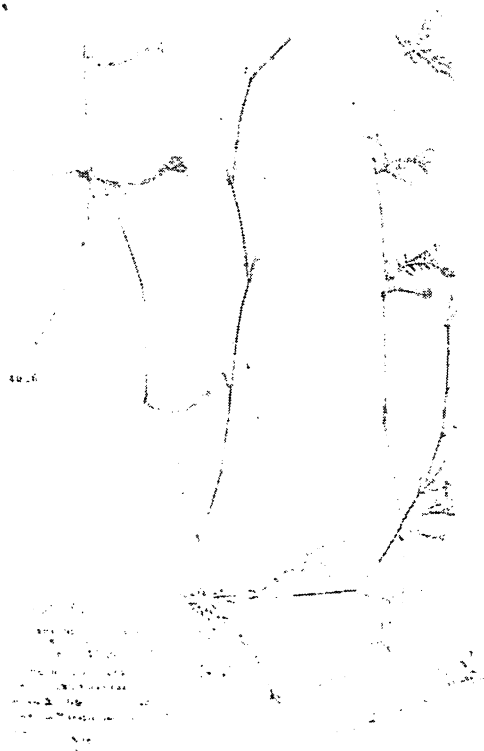
Drosera burmanni Vahl, *Symb. Bot.*, 3 : 50, 1794 ; Clarke in *Fl. Brit. India*, 2 : 424, 1878.

This perennial herb with radical, rosulate cuneate-spathulate leaves was found in abundance all along the swale of undulating sand-dunes facing the seacoast at Digha. It grows on rather slopy, wet, sandy or gritty soils in groups of threes or fives or rarely in a solitary manner. Occasionally, it was found growing

in swales populated by *Cynodon dactylon* (L.) Pers. This taxon is reported to occur throughout India in the plains from Ceylon and Bombay and the base of outer Himalayas up to 1,200 m and in S. India up to 2,500 m. Its occurrence near Digha and Travancore coasts (Thomas, 1962) is significant for it supports the concept that distribution in certain plants is governed by topography and not by climate.

Ecology Section,   T. Ananda Rao.
Botanical Survey of India,   A. K. Mukherjee.
76, Lower Circular Road,
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NUCLEOLUS IN THE GENUS *COIX*

The five species included in the genus *Coix* of the tribe Maydeæ constitute a polyploid complex. All of them, however, except *C. gigantea* are reported to bear a single nucleolus.[1] During the course of a detailed cytological investigation of this genus, a few interesting observations pertaining to nucleolus were made by the author which form the present note.

C. aquatica and *C. poilœni* ($n = 5$) are the two diploid species. Material of *C. aquatica* used during the present study was collected from two sources, (*i*) natural populations of Saugor, M.P., and (*ii*) plants raised at Agra from seeds obtained from Saugor. In the first stock microspore mother cells as well as cells of the tapetum had a single nucleolus per nucleus. In the second stock, however, 23% of the total nuclei scored, possessed two or more nucleoli (Fig. 1). The accessory nucleoli which were spherical in shape and smaller in size, remained apart from the major nucleolus.

Material of *C. lacryma* ($n = 10$), the tetraploid species (earlier studied by several authors)[1-3] was collected from plants raised at Agra from seeds obtained from Andhra Pradesh. Though majority of the microspore mother cells studied, possessed a single nucleolus per nucleus but cells with two nucleoli were also common (Fig. 2). Nirodi[1] has reported only uninucleolate condition in all the three varieties of this species, studied by her. The supernumerary nucleolus in this species was as deeply stained as the major nucleolus but was smaller in size.
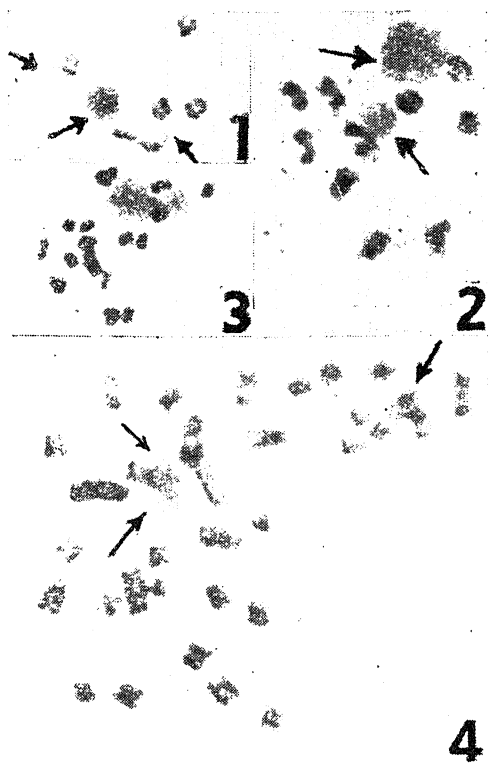
FIGS. 1–4   Fig. 1. Diakinesis in *C. aquatica*. Note 5 II and 3 nucleoli.   Fig. 2. Diakinesis in *C. lacryma*. Note 10 II and 2 nucleoli.   Fig. 3. Diakinesis in aneuploid *Coix* species. Note 16 II and 2 nucleoli. Fig. 4. Somatic metaphase in aneuploid *Coix* species. Note 32 chromosomes and 3 nucleoli. (All Figures, × 1,680).

Recently Koul and Paliwal[4] have described the karyotype and meiosis of an aneuploid *Coix* species ($n = 16$). This species as well, presents variations in nucleolar number. Of the 230 nuclei scored, 50 were binucleolate (Figs. 3 and 4) and all the rest uninucleolate. The accessory and the major nucleolus stain alike and they either keep appressed or apart. In

C. gigantea ($n = 20$), the octoploid species, binucleolate condition is already on record.

The number of nucleoli per nucleus has in the past been considered a criterion to indicate polyploidy.[5-7] This assumption has its roots in the belief that each genome contributes one nucleolus organizing chromosome. Nirodi[1] has exploited this concept in establishing the autopolyploid nature of *C. gigantea*. She regards the presence of two nucleoli per nucleus in this species, as one of the evidences of its autopolyploid nature. This view, however, is questionable on two grounds. In the first instance *C. gigantea* being an octoploid species should have more than two nucleoli per nucleus if each genome carrying one nucleolus organizing chromosome could organize a separate nucleolus. Secondly, the present findings prove that the binucleolate condition is not restricted to the octoploid species but is equally, nay more common in the diploid, tetraploid and aneuploid species of this genus. Further, the present observations confirm the view[8-11] that the number of nucleoli per nucleus does not furnish an index of the polyploidy level, because the number of nucleoli per nucleus varies in the same species. As has been pointed out above, collections of *C. aquatica* made from natural populations invariably possessed a single nucleolus per nucleus. On the contrary, variability in the nucleolar number occurred in plants raised at Agra. It may be noted that the plants of *C. aquatica* were raised at Agra from seeds collected at Saugor. Anomaly in the nucleolar number, therefore, appears to have been brought about by the change in environment.

Post-Graduate Dept. of Botany,   A. K. KOUL.
Jammu and Kashmir University,
Srinagar, Kashmir, *March* 18, 1965.

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SURFACE AREA OF KAOLINITE AND BENTONITE CLAYS AS AFFECTED BY PARTICLE SIZE DISTRIBUTION

KAOLINITE clay mineral possesses 1 : 1 alumina : silica crystal structure. The colloidal material has bigger particles in the ultra range with a surface area ranging from 10 to 20 sq. m./g. It is non-plastic with low water retentivity. Whereas bentonite, being mainly montmorillonite clay, comprises of 1 : 2 type layers. It has very fine particles in the ultra range and thus possesses very high surface area of 300 to 400 sq.m./g. On wetting it is highly plastic retaining enormous water.

It will be of interest to know the particle size distribution of these clays, particularly in the ultra size range, and how the surface area is affected by particle size in case of the kaolinite and bentonite clays.

Two samples of the clays—kaolinite and bentonite—of as high a grade of purity as possible were obtained. Both samples were put to mechanical and ultra mechanical analysis and the estimation of surface area. For mechanical analysis the clays were dispersed by HCl–NaOH method (Piper, 1950). The H-clay prepared by 0·05 N HCl was treated with N NaOH to pH 10·5 for complete dispersion. This Na–clay suspension was utilised for pipetting the different sized particles. The $2\,\mu$ ($10^{-3 \cdot 7}$ cm.) particles were fractionated by the usual pipette method. But micro-pipette (Puri, 1949 a) was used for particles from $1\,\mu$ to $40\,m\mu$ ($10^{-4 \cdot 0}$ to $10^{-5 \cdot 4}$ cm.). Graphs were drawn from the values of $2\,\mu$ to $40\,m\mu$ so determined and curves were extrapolated as per the trend up to $3 \cdot 2\,m\mu$ ($10^{-6 \cdot 5}$ cm.). The summation percentages were calculated up to $40\,m\mu$ size from experimental and extrapolated values. These values of particle size distribution for two clays are given in Table I. The surface area for the clays was calculated by the relation $S = 0 \cdot 02264 \, \Sigma \, P/D$ (Puri, 1949 b), where S is the surface area in sq.m./g. and P is the percentage by weight of particles of mean diameter D. The figures of surface area are shown against the particle size in Table I.

TABLE I

Particle size distribution and surface area of kaolinite and bentonite clays

Particle size cm.	Summation percentage of particles		Surface area sq. m./g.	
	Kaolinite	Bentonite	Kaolinite	Bentonite
$10^{-3 \cdot 7}$ ($2\,\mu$)	80·6	79·6	1·9	1·8
$10^{-4 \cdot 0}$ ($1\,\mu$)	51·2	78·2	2·9	3·6
$10^{-4 \cdot 2}$	25·8	76·2	3·1	5·6
$10^{-4 \cdot 4}$	13·2	75·4	3·4	8·7
$10^{-4 \cdot 6}$	7·0	69·8	3·5	13·1
$10^{-4 \cdot 8}$	3·2	66·8	3·6	20·0
$10^{-5 \cdot 0}$ ($0 \cdot 1\,\mu$)	2·4	56·8	4·0	28·4
$10^{-5 \cdot 2}$	2·0	52·2	4·4	41·5
$10^{-5 \cdot 4}$ ($40\,m\mu$)	1·6	51·2	5·0	62·7
$10^{-5 \cdot 6}$	1·25	44·5	5·7	89·5
$10^{-5 \cdot 8}$	1·0	33·0	6·5	125·1
$10^{-6 \cdot 0}$ ($10\,m\mu$)	0·75	31·75	7·5	171·7
$10^{-6 \cdot 2}$	0·5	25·2	8·5	227·5
$10^{-6 \cdot 4}$	0·5	18·75	10·5	289·2
$10^{-6 \cdot 5}$ ($3 \cdot 2\,m\mu$)	0·25	15·75	10·0	320·3

It could be seen that with decrease in particle size, surface area keeps on increasing. The kaolinite clay does not change much in summation percentage of particles after the size of $10^{-4 \cdot 6}$ cm. That means that it has hardly any fine particles in the ultra range. Therefore, the surface area of kaolinite is not influenced to any extent. The total area has been only 10 sq.m./g. which is 5 times that of the size at the starting point (*i.e.*, $2\,\mu$). The bentonite clay presents definite gradation of fine particles below $1\,\mu$ size and even in the last limit it indicates 15·75% particles. Virtually, the surface area is very high at each stage of particle size as compared to kaolinite. The total surface area of bentonite being 320 sq.m./g. has been found to be 178 times of the stage at $2\,\mu$ and 32 times that of total surface area of the kaolinite.

College of Agriculture,   H. J. RAJANI.
Junagadh (Gujarat), *March* 15, 1965.

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REVIEWS AND NOTICES OF BOOKS

Protides of the Biological Fluids (Vol. 12). Edited by H. Peeters. (Elsevier Publishing Company Ltd., 12 B Rippleside Commercial Estate, Ripple Road, Barking, Essex, England), 1965. Pp. xi + 482. Price 120 *sh.*

This volume represents the Proceedings of the Twelfth Colloquium, Bruges, held in 1964.

The central figure of the *Academic Session* was Professor Schultze who discussed the biologically active fragments of proteins using his own work as the basis for a survey of the activity of protein fragments and for forging the links between structure and function of the subunits of the individual protein molecule.

The dominant subject of this meeting was *Phylogeny*. The relationship between the descendants of correlated groups now existing lies between the surprising facts known concerning the structure of the palæontological shell-matrix and its comparison with contemporary molecules within the same species. A number of molecules such as hæmoglobin have been carefully studied and appear to carry the lines of growth, or even the scars, of evolution.

The subsequent section dealt with the *Tissue Proteins*. The biological fluid on one side of the membrane of a living cell is different from that existing on the other. The cellular proteins very often exhibit the characteristics of a given tissue in addition to those of a given organism.

A special section dealt exclusively with the *Urinary Proteins* to be followed, logically, by a session concentrating on *Glycoproteins*, interest in which has been aroused since its discovery in the products of renal excretion.

The Symposium terminated with contributions in the *Technical Section* and some biochemical topics designed to stimulate their discussion and point the way for future research.

C. V. R.

Scientific Uncertainty and Information. By Leon Brillouin (Academic Press, New York and London), 1964. Pp. xiv + 164. Price $ 6.50.

This thought-provoking book, written by a well-known and distinguished scientist who is a member of the International Academy of Philosophy of Science, presents a complete reappraisal of the philosophical foundations of science. Professor Brillouin describes the dramatic expansion undergone by physics and other experimental sciences in this century, and shows how new discoveries have led to a profound transformation of scientific theories. Instead of strict determinism, there exist only laws of probability, representing a type of loose causality. This has rendered meaningless most of the classical discussions of philosophers about scientific knowledge and has necessitated a complete theoretical reconstruction. A book of wide interest to all scientists, physicists, and philosophers.

C. V. R.

Counterexamples in Analysis. By Gelbaum and Olmsted. (Holden-Day, Inc., 728 Montgomery Street, San Francisco), 1964. Pp. xxiv + 194. Price $ 7.95.

While *Counterexamples in Analysis* is intended primarily for browsing, the correlative purpose of this unique book is to unify mathematical ideas. By providing insights into analysis it accomplishes this purpose and helps the reader to order his ideas and deepen his mathematical knowledge.

The subject-matter is dealt with in two parts, *viz.*, Part I. Functions of a Real Variable and Part II. Higher Dimensions. The titles of the articles under Part I are as follows : The Real Number System ; Functions and Limits ; Differentiation ; Riemann Integration ; Sequences ; Infinite Series ; Uniform Convergence ; Sets and Measure on the Real Axis.

The titles of the articles under Part II are as follows : Functions of Two Variables ; Plane Sets ; Area ; Metric and Topological Spaces ; Function Spaces.

C. V. R.

Automatic Control. By C. R. Webb. (McGraw-Hill Publishing Company Ltd., Shoppenhanger's Road, Maidenhead, Berks.), 1964. Pp. xi + 303. Price 42 *sh.*

The book provides both student and practising engineer with a general appreciation of Control, and encourages investigation of the practical aspects of Control Engineering. It will serve engineering undergraduates, students working for their Diploma in Technology, and those reading Control for Higher National

Certificates and Diplomas in Mechanical and Production Engineering. It will also be suitable for the engineer and scientist, without any formal training in Control, who is looking for a short non-specialized text.

The approach is through an analytical study of common transfer functions, leading to the use of the root locus. Transient and harmonic analyses of closed-loop systems are shown to derive naturally from the root locus pattern, and the treatment concludes with a study of Bode and Nichols diagrams, and various techniques used for compensation. Emphasis is on linear single-loop systems, although non-linear systems are introduced in the last chapter. Reference is made to the Laplace transformation method for those who wish to make use of it, but no part of the text requires a knowledge of operational method for its full understanding.

C. V. R.

Symplectic Geometry. By Carl Ludwig Siegel. (Academic Press, New York and London), 1964. Pp. vii + 86. Price $ 6.00.

The following is the list of articles contained in this volume : Introduction ; The Symplectic Group ; The Symplectic Metric ; Discontinuous Groups ; Hermitian Forms ; The Fundamental Domain of the Modular Group ; The Fundamental Domain of the Group A ; The Volume of the Fundamental Domain of the Modular Group ; Commensurable Groups ; Unit Groups of Quinary Quadratic Forms.

C. V. R.

Computer-Oriented Mathematics. By Kovach. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. vii + 98. Price : $ 3.95 ; Paper $ 2.95.

Everyone today is conscious of the electronic computer, but to most people it remains either completely incomprehensible or some sort of almighty genius. It is the purpose of this book to show that the computer is neither.

The articles contained in this book are as follows : 1. Characteristics of Digital Computers ; 2. Various Number Bases ; 3. Getting Started with a Guess ; 4. Interpolation, or Filling in the Gaps ; 5. Approximations, Plain and Fancy ; 6. Iteration : Repetition with a Purpose ; 7. Relaxation Methods ; 8. Monte Carlo Methods ; 9. Some Special Techniques ; 10. Computer Applications—Present and Future ; 11. Bibliography for Further Study.

C. V. R.

Foundations of General Topology. By William J. Pervin. (Academic Press, New York and London), 1964. Pp. xi + 209. Price $ 7.95.

This book presents a comprehensive development of point-set topology. The material is pedagogically oriented and rigorously treated, enabling the graduate or upper-class undergraduate with no previous background in topology to progress to an understanding of concepts basic to modern research.

The articles contained in this book are as follows : Algebra of Sets ; Cardinal and Ordinal Numbers ; Topological Spaces ; Connectedness, Compactness, and Continuity ; Separation and Countability Axioms ; Metric Spaces ; Complete Metric Spaces ; Product Spaces ; Function and Quotient Spaces ; Metrization and Paracompactness ; Uniform Spaces.

C. V. R.

Mechanisms of Immunological Tolerance. Edited by M. Hasek, A. Lengerova and M. Vojtiskova. (Academic Press, New York and London), 1962. Pp. 544. Price $ 18.00.

This book represents the proceedings of the symposium on "Mechanisms of Immunological Tolerance", organized by the Institute of Experimental Biology and Genetics of the Czechoslovak Academy of Sciences and held at the House of Scientific Workers at Liblice near Prague on 8–10th November 1961. It contains all papers presented on the six main topics in their original sequence with the respective discussions of the special questions and concluding discussion of a more general nature. The titles of the main topics are as follows : 1. Immunological Tolerance in the Classical Sense ; 2. Immunological Tolerance and Tumour Problems ; 3. Tolerant States Induced in Adult Organisms or Cells ; 4. Immunological Tolerance in Radiation Chimæras ; 5. Immunological Enhancement and the Nature of Isoantigens ; 6. Tolerance and Autoimmunity.

C. V. R.

Biomedical Sciences Instrumentation (Vol. 2). Edited by William E. Murry, M.D. and Peter F. Salisbury, M.D., Ph.D. (Plenum Press, New York), 1964. Pp. viii + 296. Price $ 12.50.

This volume represents the Proceedings of the Second National Biomedical Sciences Instrumentation Symposium, sponsored by Instrument Society of America, held May 4-7, 1964, at the University of New Mexico, Albuquerque, New Mexico. (A publication of Instrument Society of America.)

The volume continues the up-to-the-minute coverage of advances in the vigorous new field of biomedical sciences instrumentation begun in the first volume. This latest work elucidates several important and specific areas in the borderland between engineering and physics on the one hand and physiology and medical science on the other. Several topics such as "Eye-Movements", "Vibratory Energy Transmission as a Tool for Diagnosis and Treatment", and "Implantable sensors", have not been discussed within the last 5-years in spite of their evident importance, and thus these papers represent fresh investigations.

C. V. R.

The Harvey Lectures (Series 58). (Academic Press, New York and London), 1963. Pp. xv + 331. Price $ 9.50.

This book contains a collection of "The Harvey Lectures" delivered under the auspices of the Harvey Society of New York, 1962-63.

The following is the list of the titles of the lectures : The Chemical Study of Single Neurons, by Oliver H. Lowry ; The Role of Antigen-Antibody Complexes in Disease, by Frank J. Dixon ; Osmotic Regulation in Higher Vertebrates, by Knut Schmidt-Nielsen ; Renal Tubular Function : Lessons from Micropuncture, by Carl W. Gottschalk ; Cytological Aspects of Hemoglobin Production, by Marcel C. Bessis ; The Problem of Tracking Fiber Connections in Nervous System in Relation to Their Functional Specificity, by Wilfrid E. Le Gros Clark ; Factors Influencing Protein Requirements, by Nevin S. Scrimshaw ; The Theory of Cells in Relation to the Study of Cytoplasmic Inheritance in Amœbæ by Nuclear Transfer, by J. F. Danielli ; and Active Processes in the Brain Stem during Sleep, by G. Moruzzi.

C. V. R.

Positronium Chemistry. By James Green and John Lee. (Academic Press, New York and London), 1964. Pp. xii + 105. Price $ 5.50.

A new topic of chemistry, grounded in basic theoretical, nuclear, and solid state physics, is the subject of this important book.

A theoretical introduction to the quantum electrodynamics of positron interaction precedes experimental data and a discussion of *ortho*-and *para*- positronium in gases, solids, and liquids. The chemical properties of the element are explored, developing a new aspect, and applications to the physical and biological sciences are suggested.

Positronium Chemistry will be of interest to nuclear and solid state physicists, astrophysicists, chemists, and biophysicists.

C. V. R.

Experimental Endocrinology. (A Source-book of Basic Techniques). By M. X. Zarrow, J. M. Yochim, and J. L. McCarthy. (Academic Press, New York and London), 1964. Pp. xvi + 519. Price $ 15.00.

This book is designed as a text-book and manual for use in an advanced course or for use by the individual student in a project course. Its primary aim is to train the student in the basic laboratory techniques used in endocrinology, and to give him an appreciation of the *whole animal*. The experiments are planned so that quantitative data may be obtained wherever possible.

The subject-matter is dealt with in fourteen chapters whose titles are as follows : 1. Introduction ; 2. The Estrogens ; 3. The Progestogens ; 4. Relaxin ; 5. The Androgens ; 6. Epinephrine and Norepinephrine ; 7. The Adrenal Corticoids ; 8. The Thyroid Hormones ; 9. Somatotropin, Corticotropin, and Thyrotropin ; 10. The Gonadotropins ; 11. Oxytocin, Vasopressin, and Melanocyte-Stimulating Hormone ; 12. Parathormone ; 13. Insulin and Glucagon ; 14. The Invertebrate Hormones.

C. V. R.

Advances in Virus Research (Vol. 10). Edited by Kenneth M. Smith and Max A. Lauffer. (Academic Press, Inc., New York and London), 1963. Pp. viii + 277. Price $ 11.50.

This volume successfully maintains the catholicity of its predecessors. Two of the six contributions deal with viruses of vertebrates, two with plant viruses, one with bacteriophage and the sixth with structure as revealed by electron microscopy.

In the initial article on interferon, Alick Isaacs provides a concise summary of knowledge accumulated since the original isolation and characterization of interferon at his laboratory in 1957. Following sections on the production of interferon, its properties, purification, mode of action and role in recovery from virus infection, there are short discussions of its potential use in therapy and of the recent observations that interferon production may be initiated by the introduction into cells of any (not only viral) foreign nucleic acid.

Samuel Baren in the next chapter on mechanism of recovery from viral infection also

deals with interferon, as well as with other non-specific factors such as temperature, acidity, and oxygen tension. He concludes that specific antibody probably serves primarily to protect the host from reinfection whereas various non-immune mechanisms appear to determine recovery from a primary virus infection.

The application of such technique as density gradient equilibrium sedimentation, autoradiography, electron microscopy, birefringence and X-ray diffraction toward the elucidation of size, shape, molecular weight and orientation of bacteriophage nucleic acid form the basis of Irwin Bendet's contribution. Present evidence indicates that bacteriophage nucleic acid exists as a single molecule which exhibits a preferential orientation with respect to the long axis of the particle.

Horne and Wildy have contributed a comprehensive treatise on virus structure as revealed by negative staining. Following a general description of virus particles and a plea for uniformity in the use of such terms as capsid and capsomere, there are sections on symmetry and preparative techniques for the electron microscope. Individual viruses are then classified according to type of symmetry, or lack of symmetry exhibited. This is an excellent survey with remarkably clear photographs and diagrams.

In the final articles, W. C. Price discusses the inactivation and denaturation of plant viruses while B. Kassaris deals with their various interactions in plants. Price notes that the best studied plant viruses are those that are stable and may be isolated in quantity by biochemists and biophysicists. He then makes the interesting comment that the "plant virologist" cannot be so selective but "......... must be concerned with viruses that cause extensive damage to crops.........."

Now that ten volumes have appeared it would be helpful to have all of the subject indices integrated so that references to material in all volumes might be available in one place.

DONALD E. CAREY.

Principles of Atomic Orbitals. By N. N. Greenwood. (Royal Institute of Chemistry, 30 Russel Square, London, W.C. 1), 1964. Pp. 46. Price 6 *sh*.

This is the eighth monograph in the series *Monographs for Teachers* published by the Royal Institute of Chemistry. Besides its use

as a guide to teachers of chemistry at higher levels, this little booklet, as a general summing-up of present ideas on atomic orbitals in clear terms with formulæ and figures, should appeal to a wider readership including advance students of chemistry in colleges.

A. S. G.

Fundamentals of Botany Series. (Published by Macmillan, St Martin's Street, London, W.C. 2), 1965. Price 12 *sh*. 6 *d*. each.

The Plant Cell. By W. A. Jensen.

Reproduction, Heredity and Sexuality. By S. A. Cook.

Form and Function of Non-Vascular Plants. By W. T. Doyle.

Form and Function of Vascular Plants. By F. B. Salisbury and R. V. Parke.

Plants and the Ecosystem. By W. D. Billings.

Plants, apart from their utility, have a universal appeal. Every aspect of a plant's life—its underground rooting, its overground shooting, its leafing, its flowering and fruiting, its reproduction—evokes in man a sense of wonder and enthuses him with a spirit of inquiry. A close study of plant is indeed a way to understand the significance of life.

There is no doubt that this series on "Fundamentals of Botany" brought out by Macmillans will find immediate appreciation not only by students of botany but by any intelligent lay-reader.

Each volume (about 150 pages and priced 12 *sh*. 6 *d*.) is profusely illustrated, and includes the exciting developments that have taken place in recent years in the particular branch it discusses.

A. S. G.

Books Received

Differential Equations. By L. W. F. Elen. (Macmillan & Co., London W.C. 2), 1965. Pp. viii + 220. Price 18 *sh*.

Light and Life in the Universe. Edited by S. T. Butler and H. Messel. (Pergamon Press, 4 and 5 Fitzory Square, London W. 1), 1965. Pp. 340. Price 17 *sh*. 6 *d*.

Fish as Food (Vol. IV) *Processing* (Part 2). Edited by G. Borgstrom. (Academic Press, New York-10003), 1965. Pp. xiv + 517. Price $ 18.50.

The Evolution of Genetics. By A. W. Ravin. (Academic Press, New York-10003), 1965. Pp. x + 216. Price $ 2.95.

SCIENCE NOTES AND NEWS

The Indian Academy of Sciences

At the invitation of the Osmania University, the Council of the Indian Academy of Sciences have decided to hold the Thirty-First Annual Meeting of the Academy at Hyderabad on the 20th, 21st and 22nd December, 1965.

The Indian Pharmaceutical Congress Association

The 17th Session of the Indian Pharmaceutical Congress Association, consisting of Industrial Pharmacy, Professional Pharmacy, Pharmacognosy and Phytochemistry, Pharmacology and Microbiology, Pharmaceutical Education and Indigenous Pharmacy Sections, will be held during December 27th to 30th, 1965, at Banaras Hindu University, Varanasi. For further particulars please write to Dr. Diptish Chakravarty, Hon. General Secretary, Indian Pharmaceutical Congress Association, 18, Convent Road, Calcutta-14.

Symposium on 'Metallurgy of Substitute Ferrous and Non-Ferrous Alloys'

A Symposium on 'Metallurgy of Substitute Ferrous and Non-Ferrous Alloys' will be held under the auspices of the National Metallurgical Laboratory in early 1966. Further particulars can be had from Dr. T. Banerjee or Mr. R. M. Krishnan, National Metallurgical Laboratory, Jamshedpur-7.

Seminar on Electrochemistry

The Sixth Seminar on Electrochemistry will be held at the Central Electrochemical Research Institute, Karaikudi, on December 26, 27, 28 and 29, 1965. There will be the following Technical Sessions : 1. Electrode kinetics, Electrochemical equilibria and Electro-analyses ; 2. Electro-organic and inorganic products ; 3. Electrothermics and Electrometallurgy ; 4. Batteries ; 5. Electrodeposition and Metal Finishing ; 6. Corrrosion ; 7. Miscellaneous.

Further details can be had from Dr. K. S. Rajagopalan, Convener, Central Electrochemical Research Institute, Karaikudi-3, Madras State.

The Geochemical Society of India

A Society known as the "Geochemical Society of India" was established on 20th August 1965 with its Headquarters at Patna, India. Among the chief programmes of the Society will be the publication of quarterly bulletins containing abstracts and summary data of the work on geochemistry being done in India. For further particulars please write to Dr. D. N. Ojha, Executive Secretary (Patna), or Dr. R. C. Sinha, Executive Editor, Department or Geology, Patna University, Patna-5 (Bihar), India.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Nuclear Physics to Sri B. V. Narasimha Rao for his thesis entitled "Lifetimes of Excited States of Nuclei with a Delayed Coincidence Spectrometer" ; and Ph.D. degree in Chemistry to the following candidates for their theses—title noted against each ; Sri B. R. L. Row—"Studies on the Hydrolysis of Metal Ions : Zinc (II) and Protactinium (V)", Sri A. S. R. Anjaneyulu—"Chemical Examination of Local Alkaloidal Plants and Synthesis and Study of Isoflavanones, Isoflavan-4-ols Isoflavenes and Isoflavenes", Sri K. Suryanarayana Murty—"Studies in Cerate Oxidimetry : Ammonium Hexanitrate Cerate as an Oxidimetric Reagent", Kumari C. Rukmini—"Chemistry of Triterpenoids Saponins and Synthesis of Furano-Benzo Pyrenes", Sri D. Satyanarayana—"Studies on Some Vanadium (V) Complexes and Their Analytical Applications", and Ph.D. degree in Zoology to Sri V. Chalapati Rao for his thesis entitled "Chemical Oceanographic Studies in the Bay of Bengal".

The M.S. University of Baroda has awarded the Ph.D. degree in Chemistry to Shri Pravin Maganlal Desai for his thesis entitled "Chelating N-Ligands Derived from Acetoacet (Aryl) Amides and their Complexes with Transition Metal Ions"; and Ph.D. degree in Mathematics to Shri Bhuri Singh Yadav for his thesis entitled "Absolute Convergence of Fourier Series".

Sri Venkateswara University has awarded the Ph.D. degree in Zoology to the following candidates for the thesis noted against each : Smt I. Kumudavalli—"Studies on the Distribution of charges in Metabolism of tissues of animals exposed to altered environment (Protein Ionization during Muscle Recovery)", Sri P. Venkateswara Rao—"Studies on the Peripheral Nervous Systems of an Arachnid, *Heterometrus fulvipes*", Sri V. Sree Ramachandra Murty—"Studies on the Proprioceptors in an Arachnid, the Scorpion, *Heterometrus fulvipes*".
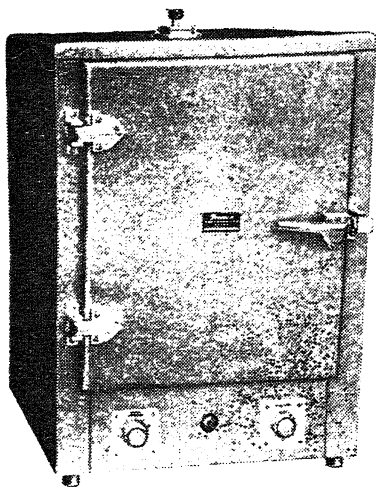
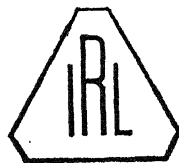# COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
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THE NEW PHYSIOLOGY OF VISION

Chapter XXVIII. Observations with a Neodymium Filter

Sir C. V. RAMAN

GLASS disks coloured by neodymium oxide makes useful filters with which it is possible to cut out the yellow light of a mercury lamp (5770–5790 Å), while allowing the green light of the lamp (5461 Å) to be freely transmitted. Some specimens of such glass being available, it appeared worthwhile to examine the effect of placing a filter made of it before the observer's eye when viewing luminous objects. The changes in their appearance noticed in various cases are of such a striking nature that it appears desirable to place the observations on record.

Three plates were available, each about four millimetres thick. Viewing the sky through a spectroscope with one such plate placed before the slit of the instrument, an intense and sharply defined absorption covering the wavelength range from 570 mμ to 600 mμ is visible. In other words, the filter cuts out the yellow light from the spectrum. Feeble absorption bands are noticed in the green part of the spectrum between 500 mμ and 530 mμ. There is also a noticeable weakening of the blue part of the spectrum between 460 mμ and 480 mμ. These other absorptions become very prominent when all the three plates are put together. But when only one plate is employed, they could be considered to be of negligible importance in comparison with the complete exclusion of the yellow from the spectrum by the principal absorption band.

Luminosity and Colour.—The reduction in absolute luminosity produced by the introduction of the filter becomes strikingly evident when we view an intensely luminous field, as for example, a part of the sky not far away from the sun. This region which appears insupportably bright to the eye without the filter could be tolerated when the filter is put in. Clouds in the vicinity of the sun which dazzle the eye when looked at directly could be viewed and their texture critically examined through the filter. The large contribution to luminosity made by the part of the spectrum between 570 mμ and 600 mμ is thus made evident.

The effect of removing the yellow from the spectrum is even more striking in respect of the colours of various objects viewed through the filter. These effects are indeed of a rather paradoxical nature. The blue sky seems bluer when viewed through the filter. Green vegetation appears greener when seen through the filter than when viewed directly. Objects which normally exhibit red hues appear of a deeper and more saturated red colour. The explanation of these changes is not far to seek. A large contribution to the observed luminosity of the objects under view is made by the part of the spectrum between 570 mμ and 600 mμ. When this is excluded by the filter, the luminosity of the object is reduced. At the same time, the diluting effect of the yellow light on the colour of the perceived light is also abolished. The intrinsic colour of the object is thereby made more evident.

Many examples could be mentioned of the remarkable way in which the colours of familiar objects are altered by viewing them through the filter. Common sand and gravel laid on roads usually appear of a brownish-yellow colour by reason of their iron content. Viewed through the filter, they change to a brick-red hue. Fresh leaves which are of a greenish-yellow colour turn into a full green and appear like mature leaves, while mature green leaves turn into a darker green. Flowers are a particularly interesting study. Pelargoniums, for example, exhibit striking changes. Those which are of a pale rose-red hue appear quite red. Orange pelargoniums turn to a scarlet and scarlet pelargoniums to a bright red. Examples of such changes can be multiplied indefinitely. Perhaps the most startling effects are those exhibited by human complexions which when viewed through the filter appear suffused with blood. Striking changes also appear in the colours of the sky at the time of sunset, yellow hues turning to an orange red.

Colours of Interference.—Very interesting effects are observed when thin films exhibiting patterns of interference colour due to variable thickness are viewed through a neodymium filter. These effects are of different kinds, being respectively those noticed in areas where colours are ordinarily observable, those arising in the areas immediately surrounding them where little or no colour is ordinarily visible, and finally, those noticeable in more remote regions where the path differences are larger.

The first class of effects may be observed with Newton's rings or other arrangement exhibiting the colours of thin films of air. There is a notable reduction in the luminosity of the entire pattern and this is accompanied by striking changes in the distribution of luminosity as well as in the colours which are observed. The variations in luminosity as we proceed outwards from the centre of the pattern are less striking, though the first dark ring remains as a conspicuous feature. The spectral yellow along the circles of maximum luminosity disappears, while the colours seen in the adjoining regions gain in vividness. The cycles of the colour are replaced by green and red bands of strongly contrasted colour which are sharply demarcated from each other. Beyond the fifth ring of colour, numerous additional dark and bright rings spring into view. Some ten or twelve of these rings can be counted, five or six being perfectly achromatic, while those beyond which are less conspicuous appear edged with colour.

A convenient arrangement for observing the effects described above is to use two ordinary plates of glass each ten centimetres square in area and about half a millimetre thick. After being carefully cleaned, the plates may be placed in contact so that only a thin film of air separates their surfaces. With a little gentle pressure, this air-film can be squeezed out from some areas which then exhibit interference colours. Viewing such an air-film through the filter, the various phenomena referred to above can be readily observed, and in addition, the entire area between the plates will be found to be covered with interference bands in areas where they would not be seen unless monochromatic light sources are employed. ,

We now proceed to comment on the explanation of the effects described above. It is well known that by using a colour filter which cuts out most of the spectrum except a limited region, the number of interferences which can be seen and counted can be greatly increased. A red filter which cuts out all wavelengths less than 600 mμ may be cited as an example. An orange filter which cuts out all wavelengths less than 550 mμ produces similar effects but is not so satisfactory. The distinctive feature of the case with which we are now concerned is that the filter removes the limited region between 570 mμ and 600 mμ but allows the rest of the spectrum to pass through. That it also results in an increase of the visible number of orders of interference is significant but is not altogether surprising. The effectiveness of the filter in this case is due to the fact that the spectral regions adjoining the absorption band are both quite luminous, $viz.$, the green sector and the red sector respectively. Hence, they can both give rise to readily observable interference patterns. The superposition of these patterns is evidently responsible for the effects observed in the various regions and the differences between them.

QUANTUM ELECTRONICS AND COHERENT LIGHT*

THE course ran from August 19 to August 31 1963, and its Director was C. H. Townes and it was attended by eighty-two persons. The subject-matter of the course was covered in a series of lectures and the following were the speakers and the respective topics dealt with by them : C. H. Townes—Maser amplification and coherent light—Introduction ; A. L. Schawlow—Optically pumped masers and solid-state masers ; B. Lax—Infra-red semiconductor lasers ; G. Toraldo di Francia—Theory of optical resonators ; W. E. Lamb, Jr.—Theory of optical maser oscillators ; H. Haken and H. Sauermann—Theory of laser action in solid-state, gaseous and semiconductor systems ; J. P. Gordon—

Noise at optical frequencies ; information theory ; F. T. Arecchi—Thermal effects in a He-Ne optical maser ; A. S. Grasiuk and A. N. Oraevskij—The dynamics of quantum oscillators ; P. Connes—Fourier-transform spectroscopy ; P. Connes—High-resolution interferometric spectroscopy ; W. Low—Ions in crystals ; S. S. Yatsiv—Vibronic spectra in gadolinium compounds ; N. Bloembergen—Non-linear optics ; O. Krokhin—The intensity-dependence of optical absorption in semiconductors ; O. Svelto —Photomixing in semiconductors ; A. Javan—Stimulated Raman effect ; B. P. Stoicheff—Stimulated Raman scattering ; R. Y. Chiao, E. Garmire and C. H. Townes—Raman and phonon masers ; J. L. Emmett—High-intensity flash tubes ; J. Haisma—Some properties of a small gas laser ; Z. Bay and H. S. Boyne—The use of terahertz photobeats for precise velocity-of-light measurements.

IN VITRO CULTIVATION OF DIACHEA SPLENDENS PECK

(MISS) P. U. INDIRA

University Botany Laboratory, Madras-5

THE difficulties of culturing Myxomycetous species in the laboratory are well known. One of the reasons for repeated failures to obtain cultures from spores is perhaps the rapid loss of viability of spores in storage. Up to the year 1963,[1] only about 30 species are listed as having been grown from spore to spore even in crude cultures, and subsequent additions to this list are relatively few.[2]

In an attempt to obtain plasmodia for study in culture, spores of several species of Myxomycetes were separately seeded on agar surface (3% carrot decoction agar and 3% oatmeal agar) in Petri dishes and test-tubes. Of these, the following species developed plasmodia and eventually fruited in culture :

Physarum cinereum (Batsch.) Pers.,
P. vernum Fries,
P. gyrosum Rost.,
P. serpula Morgan,
Diachea splendens Peck.

Except for *P. gyrosum*[1] this is, as far as the author is aware, the first report of *in vitro* cultivation of these species. Of these, *P. serpula* and *D. splendens* could not be maintained for long in the plasmodial state as they fruited too rapidly. The remaining species are being studied in detail. An account of the culturing of *D. splendens* alone is presented here in some detail because no one seems so far to have succeeded in culturing any species of the interesting genus *Diachea*.[3]

The spores of *D. splendens* used here were from sporangia collected in nature on dead twigs and on stems and leaves of some living herbaceous plants, beneath a hedge in the University Botany Laboratory Campus, Madras, in December 1963 (Herbarium MUBL/PUI-62). Sporangia showed the typical structure of the species but had very short stipes.

When seeded on agar, plasmodia of this species appeared after about 3 weeks, and on subsequent transfer to oat agar and carrot decoction agar in 250 ml. Erlenmeyer flasks, they fruited regularly in about 2 to 3 weeks after transfer. Unlike in the other species, fruiting occurred before the plasmodium attained considerable size, and the entire plasmodium seemed to be used up in the process.

From the limited observations made, it appeared that the plasmodium of *D. splendens* was delicate, being composed of slender veins and small advancing fans. While it grew well on oat agar, often piercing into the agar and growing beneath the surface, fruiting was observed more regularly on carrot decoction agar. The fructifications usually appeared on the sides of the culture flask (Fig. 1).
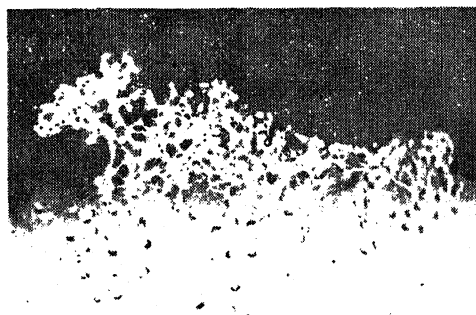

FIG. 1. Colony of fructifications of *Diachea splendens* on the sides of the culture flask, away from the agar surface (white region in the background) *c.*, × 3·5.

The fructifications obtained in culture differed in many ways from those collected in nature. They were smaller in size, usually measuring 0·25 or 0·3 mm. in diameter against those in nature which measured about 0·5 mm. Often they were sessile, being grouped on the thick calcareous hypothallus. In most cases, capillitium was poorly developed.

Spores that developed in culture were highly variable in size, being 8 to 18 μ unlike those in nature which had a fairly constant diameter of 10 μ. However, most of the spores were within a narrow range of 9·5 to 11·0 μ, and the average was close to that in nature, being 10·5 μ. The most striking difference was in spore-marking. The spores in nature were marked with coarse ridges arranged in a crude reticulum. But the reticulate arrangement was not evident in the spores developed in culture which bore crude, sparsely distributed warts or spines which were occasionally united into irregular ridges.

DISCUSSION

In view of Alexopoulos' finding[4] that members of the Physarales have a 'phaneroplasmo-

dium' and those of the Stemonitales, an 'aphanoplasmodium', it was of interest to find out the nature of the plasmodium in *Diachea* which forms a connecting link between these two orders. In so far as the rapid fruiting of the cultures permitted only a limited observation of the plasmodia, no definite statement can be made regarding the type of plasmodium in this genus. From chance observations of delicate fans and slender veins it may be suggested that the plasmodium of *D. splendens* is perhaps an intermediate type between the phanero- and aphanoplasmodia, such as that found in *Arcyria cinerea*.[4,5]

Morphological variations produced in culture, such as formation of sessile sporangia, imperfect development of the capillitium and formation of monstrous spores can perhaps be attributed to excessive moisture in the culture flasks, as it has been frequently observed that excessive moisture at the time of fruiting usually produces such irregularities.

The stipitate or sessile nature of the sporangia is sometimes used as a criterion for roughly separating the species *D. splendens* and *D. subsessilis,* the latter species tending to produce nearly sessile sporangia whereas the former is said to be prominently stipitate.[6,7] It is borne out from the present account that stipe length is a variable feature and *D. splendens* produces stipitate as well as sessile sporangia. The distinguishing feature is the ornamentation of the spore wall, as has also been pointed out by Hagelstein.[8] This feature has evolved into a well-developed, delicate reticulation in *D. sub-*

sessilis, whereas in *D. splendens* it shows a primitive reticulation crudely formed by ridges which in turn have developed from a union of coarse warts and spines that were originally perhaps scattered, and to which state the species seems to revert under certain conditions. Such a state is perhaps common in nature, along with an intergrading series towards the reticulate form, as the spore ornamentation in this species is variously described as very coarsely warted,[6] marked with raised bands and tubercles,[9] marked with stout scattered protuberances often confluent to form ridges,[8] etc.

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8. Hagelstein. R., *The Mycetozoa of North America*, Published by the author, Mineola, New York, 1944, pp. 111, 112.
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CATALASE IN ACTIVATED SLUDGE

M. K. C. SRIDHAR AND S. C. PILLAI

Department of Biochemistry, Indian Institute of Science, Bangalore

INTRODUCTION

SINCE the early years of the scientific study of sewage and sludges, attention has been devoted mostly to the practical aspects of their treatment and utilization. Comparatively very little work has been done on the fundamental aspects of sewage purification. One of the aspects of this biological process, on which the evidence is very meagre, is the enzymes in sewage and sludges. The available information

on this aspect relates mostly to the occurrence of some hydrolytic and oxidative enzymes in the slime on the material in the sewage filter,[1,2] in sewage and effluents,[3-7] in the iron bacterium M7[8] and other bacteria,[9-11] in activated sludge,[12-16] in anaerobic sludge[17] and in the sludge from synthetic media.[18] No attempt has, however, been made to extract and isolate the enzymes from even the rapidly purifying system of activated sludge and to study their relation to the aerobic process of purification.

Activated sludge contains a selective group of aerobic micro-organisms which efficiently purify sewage. Such a system may be expected to contain all the enzymes which have been reported to be present in aerobic micro-organisms and possibly other enzymes. The earlier work on the enzymes in activated sludge was probably limited by the lack of adequate methods and techniques, which are now available. Thus it was reported that activated sludge did not contain catalase,[19] a specific hemin containing enzyme, which is essential for the decomposition of hydrogen peroxide, a harmful product formed during metabolic oxidation. In view of the present state of knowledge of the enzymes in sewage and sludges, a systematic study of this aspect has been undertaken. The evidence collected on the catalase in activated sludge is presented in this article.

EXTRACTION OF CATALASE FROM ACTIVATED SLUDGE

The samples of activated sludge employed in the experiments were originally obtained from the plant at this Institute and were maintained in the laboratory by aeration. The efficiency of the sludge samples was daily assessed with reference to the quality of the effluents they yielded in 6 hours on aeration with raw sewage. The turbidity of the effluents ranged from 7 to 12 units (Klett-Summerson colorimeter with No. 42 filter) and the 3-minute and 4-hour permanganate values ranged from 1 to 3 mg./l. and 5 to 9 mg./l. respectively.

The sludge samples were allowed to settle for 15 minutes and then they were taken out and washed twice with tap water and once with distilled water. The water was removed by decantation and finally by centrifugation for 5 minutes. Weighed aliquots were homogenized for 10 minutes in a mortar with acid-washed sand, using various homogenizing media (Table I) at the rate of 80 ml. for 20 g. of sludge, and centrifuged at 1475 × g. for 15 minutes. The supernatant liquids were assayed for catalase activity by the method of Euler *et al.*[20] All the operations were carried out at 0° C. The protein content was determined by the method of Lowry *et al.*[21]

ASSAY OF THE ENZYME

The reaction mixture for catalase assay consisted of 2·5 ml. of 0·2 M sodium phosphate buffer pH 7·0, 2·5 ml. of 0·2 N (250 μ moles) hydrogen peroxide (Merck) and 1 ml. of enzyme preparation. The reaction mixture was incubated at room temperature (26° to 28° C.) for

TABLE I

Effect of different homogenizing media on the extraction of catalase from activated sludge

Homogenizing media		Catalase activity (μ moles H_2O_2 decomposed)
Distilled water	..	5*
Ethanol, 30%	..	10*
Distilled water	..	115
Sodium phosphate buffer, M/15 pH 7·0		115
Ethanol, 30%	..	185
Acetone, 30%	..	175

* These results were obtained when the sludge samples were merely shaken with distilled water and 30% ethanol (without homogenization).

15 minutes, and the reaction was arrested by adding 5 ml. of 2 N sulphuric acid and the residual hydrogen peroxide was titrated against 0·1 N potassium permanganate. The specific activity was expressed as μ moles of hydrogen peroxide decomposed per mg. protein under the assay conditions.

FACTORS INFLUENCING THE CATALASE ACTIVITY IN THE SLUDGE

Effect of Different Homogenizing Media on the Extraction of Enzyme.—The sludge samples were shaken separately with water and with 30% ethanol at 20% level for 10 minutes and the supernatant liquids were tested for catalase activity. The activity in the liquid was negligible. When, however, the sludge samples were homogenized with (*a*) water, (*b*) sodium phosphate buffer, and varying concentrations of (*c*) ethanol, and (*d*) acetone, the enzyme activity was observed, and it was maximum with 30% ethanol (Table I). These observations show that activated sludge contains catalase and that its activity is apparently inside the cells of the associated organisms.

Effect of Hydrogen Ion Concentration.—The catalase activity in the sludge samples was followed, using appropriate buffers, at different pH values, 2·7 to 11·0 (Fig. 1). The buffers used were: citrate-phosphate (0·2 M) for pH 2 to 5; sodium phosphate (0·2 M) for pH 6 to 8; and sodium bicarbonate-sodium carbonate (0·2 M) for pH 9 to 11. The enzyme activity was appreciable in the range of pH 5 to 9, the optimum pH being 7·0. It may be pointed out in this connection that one of the conditions for the efficient operation of the activated sludge process is pH around 7·0.[1,2]

Effect of Substrate Concentration.—The influence of varying concentration of the sub-

strate (hydrogen peroxide) on the activity of the enzyme was studied and 500 μM of the substrate was found optimal. Above this concentration, the activity of the enzyme decreased to a certain extent and then remained constant (Fig. 2).
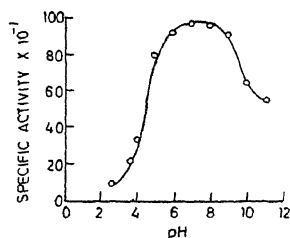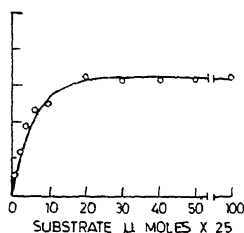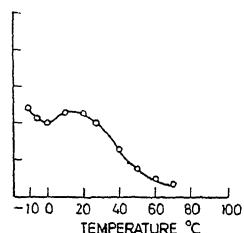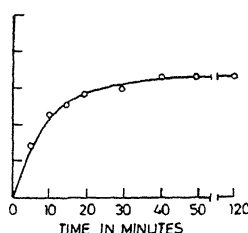

FIG. 1.   FIG. 2.   FIG. 4.   FIG. 5.

Effect of Enzyme Concentration.—The activity of the enzyme at varying concentration, from 0·1 to 5 ml, was studied. There was increased activity of the enzyme with increasing concentration, like other enzymes (Fig. 3).
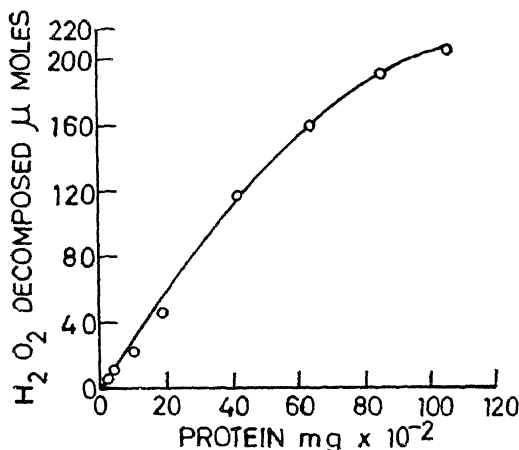

FIG. 3

Effect of Temperature.—The catalase activity at different temperatures, from — 10° C. to 90° C., was followed (Fig. 4). The maximum activity was found between — 10° C. and 20° C. and then as the temperature increased, the activity decreased. The enzyme was completely inactivated at 90° C.

In this connection it may be useful to refer to some of the reports on the effect of temperature on the activity of catalase from different sources. Stoland and Walling[23] reported that catalase seemed to differ from other enzymes of the animal body, as it did not show optimum

activity at body temperature. Margulis et al.[24] observed that the maximum activity of catalase was between 0° and 10° C. and that inactivation of the enzyme began at 40° C. Liotti,[25] working with blood and tissues of several plant and animal species, recorded that the catalase activity at pH 7·0 increased with decreasing temperature.

Effect of Drying Activated Sludge on Its Catalase Activity.—The excess activated sludge from the plant at the Institute is generally dried in the sun in a specially constructed bed with cement floor for using it as a manure and as a feed supplement for chicks. The sun-dried sludge material did not show any catalase activity.

Time Course Reaction.—The reaction mixtures were incubated at room temperature for varying period up to 2 hours. At different intervals the catalase activity was measured. After incubation for 40 minutes the reaction rate remained the same (Fig. 5). This may perhaps be due to the inhibition of the enzyme activity by hydrogen peroxide on prolonged exposure.

Effect of Inhibitors.—The effect of the following inhibitors on the enzyme activity was studied : sodium azide, mercuric chloride, copper sulphate and cobalt nitrate at varying concentrations, 0 to 500 μ moles (Table II). Sodium

TABLE II

Effect of different inhibitors on the catalase activity

Inhibitor concentration (μ moles)	Specific activity of catalase (per cent.)			
	$HgCl_2$	NaN_3	$CuSO_4$	$Co(NO_3)_2$
0	100·0	100·0	100·0	100·0
1	100·0	—	—	—
2	94·1	—	—	—
10	76·4	82·3	—	—
20	58·7	29·3	—	—
50	—	—	—	100·0
100	29·3	11·7	100·0	94·1
200	Nil	Nil	88·2	88·0
300	—	—	82·3	76·4
400	—	—	76·4	76·4
500	—	—	58·7	58·7

azide and mercuric chloride at a concentration of 200μ moles completely inactivated the enzyme. At this concentration copper sulphate and cobalt nitrate had little effect on the enzyme activity. As the concentrations of copper sulphate and cobalt nitrate were increased, the enzyme activity decreased, although this decrease was not much, even with 500μ moles.

Quality of Sludge and Catalase Activity.—
A large number of samples of activated sludge and sludge samples from septic tank were examined for catalase activity. The efficiency of these sludges, as reflected in the quality of effluents given by the sludges on aeration with raw sewage for 6 hours, was studied (Table III). The sample of activated sludge which purified sewage to a greater extent showed more catalase activity. The sludge from septic tank did not show any catalase activity.

TABLE III

Catalase activity and quality of effluents yielded by different samples of activated sludge

Activated sludge sample	Catalase activity in sludge	Quality of effluent		
		T	3-min. P.V.	4-hr. P.V.
1	384	8	2	9
2	277	18	3	12
3	255	22	5	14
4	252	35	9	18

T = Values for turbidity; 3-min. and 4-hr. P.V. = 3-minute and 4-hour permanganate values.

SUMMARY AND CONCLUSIONS

The demonstration of catalase activity in healthy activated sludge produced from domestic sewage is of considerable interest, particularly in the investigation of the biological mechanism of purification of sewage. The relatively high activity of the enzyme in the sludge samples which purified sewage more rapidly, the correlation of the enzyme activity with the quality of the sludge and the absence of the enzyme activity in the sludge samples from septic tank lend some valuable evidence on the biochemical nature of the aerobic purification process.

The enzyme from activated sludge, like that from other sources, showed activity at a wide range of pH. The optimum pH for the sludge catalase was found to be at 7·0, and it is around this pH that the activated sludge

process operates efficiently. Again, the effect of temperature on the sludge catalase is also similar to that on the catalase from other sources, but the significance of maximal activity at lower temperatures is not clear. Samples of sludge dried in the sun did not show any catalase activity.

It has been shown that the catalase activity in the sludge material is located inside the cells of the organisms and that it is not extracellular. Isolation of the dominant organisms from activated sludge and their examination for catalase activity with special reference to their relative influence on the purification process would throw further light on the mechanism involved.

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LETTERS TO THE EDITOR

ON THE *l*-FORBIDDEN M 1 TRANSITION OF Pm-147

MOST of the allowed M 1 transitions are found to have retardation factors of the order of 3–30 when compared with the single particle estimates. The *l*-forbidden M 1 transitions, on the other hand, have retardation factors of 30–80 for odd-neutron isotopes and up to 900 for odd-proton isotopes. The Pm-147 nucleus, having $Z = 61$, lies in the intermediate region between the closed shells at $Z = 50$ and 82. The 91 Kev transition results from the $d_{5/2}$ to the $g_{7/2}$ states. In the present work the lifetime of the 91 Kev level is measured with a time-to-amplitude converter[1] in order to compare the experimental transition probability with that calculated using the formula of Arima *et al.*[2]

Nd-147 is obtained as Neodymium chloride in dilute HCl with an activity of 6 mC in 8 c.c. A beta-gamma coincidence experiment is carried out for the determination of the lifetime of the 91 Kev level. The two scintillation heads in this coincidence study have NaI (T 1) crystal for gamma detection and an anthracene scintillator for beta detection each followed by a photomultiplier unit of the type RCA 6810 A. The power supply voltage of the photomultiplier associated with gamma detection is 2500 V and that associated with beta detection is 2000 V. The beta channel is biased at an energy of 200 Kev and the gamma channel is focused on the 91 Kev peak. Keeping the converter part in the maximum overlapping condition, the time spectrum is recorded. After correcting the data for chance coincidences, the time *vs.* counts are plotted as shown in Fig. 1. The half-life is obtained after a careful

FIG. 1

least square fit analysis for the points on the slope. This experimental procedure is repeated thrice and the average value of the half-life from these four sets of measurements is obtained as 2·49 ns. A total of 5% error resulting from the instrument, calibration, measurements of cable lengths is expected. Hence the half-life of the 91 Kev level can be written as

$$T_{\frac{1}{2}} (91) = 2 \cdot 49 \pm 0 \cdot 12 \text{ n sec.}$$

This value is in good agreement with the previous values.[3-6]

The experimental transition probability $T (M 1)_{exp.}$ is obtained after allowing for the corrections for internal conversion and E 2 admixture. The 91 Kev transition is estimated as 99·2% M 1 obtained from internal conversion experiments.[7] Beehuis[5] used a value of 0·266 for the conversion coefficient obtained by interpolation from the theoretical data,[8] considering conversions due to L, M, N, …shells only. But in the present case the a_K is also taken from a result of a confirmatory experiment[9] as $1 \cdot 52 \pm 0 \cdot 05$. Thus taking $a = 1 \cdot 786$ the experimental transition probabilities are obtained as $T (M 1)_{exp.} = 9 \cdot 954 \times 10^7 \text{ sec.}^{-1}$; $T (E 2)_{exp.} = 8 \cdot 024 \times 10^5 \text{ sec.}^{-1}$ The corresponding single particle estimates are obtained as $T(M 1)_{sp.} = 2 \cdot 113 \times 10^{10} \text{ sec.}^{-1}$; $T(E 2)_{sp.} = 3 \cdot 588 \times 10^5 \text{ sec.}^{-1}$; giving an M 1 retardation factor of 212 and an E 2 enhancement factor of 2.

From the expression of Arima *et al.*[2] for the transition probability of an *l*-forbidden M 1 transition given by

$$\lambda = 0 \cdot 4138 \times 10^{13} \text{ E}_\gamma^3 \ [m^2/(2 J + 1)] \text{ sec.}^{-1}$$

the m^2 being the square of the matrix element given by

$$m^2 = (J' |\textstyle\sum \mu |J)^2$$

where the J and J′ are the total angular momenta of initial and final states and $\sum \mu$ the summation of the magnetic moment operators of all the nucleons inside the nucleus, the matrix element is calculated and found to be 0·3270. The matrix element determined from the present investigation is obtained as 0·1914, the corresponding single particle value being 41.
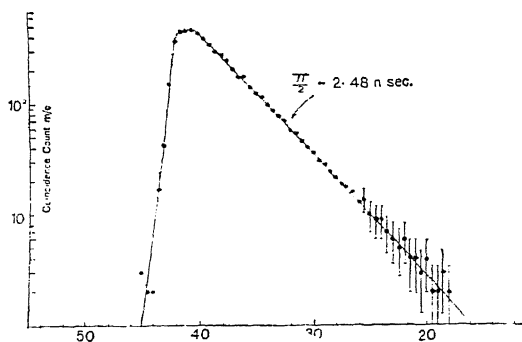
Laboratories for   K. M. M. S. Ayyangar.
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ON THE EVALUATION OF DOMAIN SIZE AND STACKING FAULT PROBABILITIES IN HEXAGONAL CLOSE-PACKED CRYSTALS

RELIABLE estimates of coherently diffracting domain size and stacking fault probabilities can be obtained for close-packed structures either by a Fourier analysis (F.A.) of Debye-Scherrer line shapes (Warren, 1959) or by an analytical study of integral line breadths (L.B.) (Rama Rao and Anantharaman, 1963 ; Wagner and Aqua, 1964). The significance of the effective particle size ($D_{eff.}$) obtained by the two methods has been examined and the following conclusions reached (Welch and Otte, 1963 ; Wagner and Aqua, 1965) :

I. When only faulting occurs, *i.e.*, $1/\eta$ or $1/\bar{D}$ tends to zero,

$$(D_{eff.}) \text{ L.B.}/(D_{eff.}) \text{ F.A.} = 2 \cdot 0 \qquad (1)$$

II. When only small domain size contributes to broadening, *i.e.*, γ tends to zero for all reflections,

$$(D_{eff.}) \text{ L.B.}/(D_{eff.}) \text{ F.A.} \geqslant 1 \cdot 0 \qquad (2)$$

In case of hexagonal close-packed structures, it is often convenient to measure the half-peak breadths of Debye-Scherrer reflections, instead of the integral breadths (Warren, 1959). The former have a value of very nearly γ/π in reciprocal space for small stacking fault densities and hence the factor $2 \cdot 0$ in equation (1) gets replaced by $3 \cdot 1$ for an analysis of half-peak breadths. Further, as the half-peak breadth is smaller than the integral breadth by a factor of $0 \cdot 89$ for the same apparent domain size

(Taylor, 1961), the factor $1 \cdot 0$ in equation (2) increases to $1 \cdot 1$ for such an analysis.

Incidentally, these two sets of factors for integral and half-peak breadths are not modified in any way, as suggested by Welch and Otte (1963), by replacing the Cauchy assumption for the line profiles by a Gaussian one.

Dept. of Metallurgy,   Shrikant Lele.
Banaras Hindu Univ.,   T. R. Anantharaman.*
Varanasi-5 India, *September* 15, 1965.

* Present Address : Keck Laboratory of Engineering Materials, California Institute of Technology, Pasadena, California, U.S.A.

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CALCULATIONS OF NQR FREQUENCIES IN COPPER SALTS

IN recent years there has been growing interest in the evaluation of electric fields in ionic solids. The improved Nuclear Quadrupole Resonance Technique has become a powerful tool to investigate experimentally, the electric fields inside the solids thus enabling the verification of the correctness of various models used in theoretical calculations.

The purpose of this note is to present the theoretical calculations carried out on three isomorphous copper salts, namely $(NH_4)_2 CuCl_4 . 2 H_2O$, $K_2CuCl_4 . 2 H_2O$ and $Rb_2CuCl_4 . 2 H_2O$ using the point charge-point dipole model, as has been done by Rao and Murthy[1] for $CuCl_2 . 2 H_2O$. The calculations have been made with respect to the electric field gradients at the site of chlorine nuclei in the crystals and the corresponding NQR frequencies have been computed using an antishielding factor γ_∞ of $-56 \cdot 6$.[2]

The crystals are tetragonal containing two molecules in the unit cell. There are two inequivalent sites for chlorines. The detailed atomic positions necessary for calculations have been taken from the X-ray data of Hendricks and Dickinson.[3,4] In order to choose between the two alternate values for the parameter W, we have calculated the proton-proton distances, using both the values. Our calculations show that $W = 0 \cdot 25$ gives more reasonable p-p-dis-

tances of 1·5 to 1·54 in agreement with experimental values.[5] The theoretical calculations of g-factors by Murthy and Premaswarup[6] also show that $W = 0.25$ is to be preferred. Hence the field gradient calculations for chlorines have been carried out with this value.

As has been mentioned earlier, the method of calculation is similar to that of Rao and Murthy except that we have studied the contribution of various ions and dipoles both induced and permanent with increasing distance, to the field gradient at the given chlorine site by a graphical method. This has enabled us to arrive at a reasonable limiting value for the field gradient.

The NQR frequencies and asymmetry parameter η are given in Table I for one type of

TABLE I

Crystal	NQR Frequency in Mcs-/sec.	Asymmetry parameter
$Rb_2CuCl_4.2H_2O$	19·4	0·19
$(NH_4)_2CuCl_4.2H_2O$	18·8	0·15
$K_2CuCl_4.2H_2O$	18·5	0·11

chlorine only, which has larger field gradient. We could not obtain a satisfactory convergence for the other chlorine by graphical method.

The directions of the principal axes XYZ of the field gradient tensor with respect to crystallographic a, b, c are given in Table II.

TABLE II

Principal values of field gradients	a	b	c
q_{zz}	45°	45°	90°
q_{yy}	45°	45°	90°
q_{xx}	90°	90°	0°

It is interesting to note that nearly same frequencies have been obtained for the three crystals showing negligible influence of substituting (NH_4), K and Rb for one another. It may be noted that the unit cell dimensions are in the order of $Rb-NH_4-K$ while the frequencies and η are also in the same order. Attempts are being made to detect these resonances experimentally. Full details will be published elsewhere.

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THE CRYSTALLINE PRINCIPLES OF EUPHORBIACEAE

Part IV.* The Triterpenes from the Stems and Leaves of *E. neriifolia* Linn.

A RECENT publication[1] from CIBA Research Centre, Bombay, has encouraged us to publish the following details of our investigation.

The leaves of *E. neriifolia* Linn. are broad and brittle. They were often used for treating bronchial infections.[2] The dry leaf powder was successively extracted with petroleum ether (b.p. 40–60°), ether and alcohol. The dark green petroleum ether extract could be separated into three crystalline components and a large amount of waxes. The separation was effected by suitable combination of fractional crystallisation and column chromatography, using alumina.[3]

Components A and B were identified to be friedelan-3 β- and 3 α-ols respectively, by direct comparison with authentic samples and through their acetyl and benzoyl derivatives.[3] Compound C is shown to be identical with taraxerol. The ether and alcoholic extracts did not give rise to any crystalline principles.

The dry stem powder was similarly extracted. Besides large quantities of waxes, friedelan 3 β-ol and taraxerol were identified in the petroleum ether extract and a new unidentified triterpene, m.p. 310–312°, $[\alpha]_D^{30} + 40°$; (Found: C, 84·35, H, 11·84; $C_{30}H_{50}O$ requires C, 84·50, H, 11·74%) has also been separated from the same extract. This compound is under further investigation.

All the compounds and their derivatives separated in this investigation have analysed satisfactorily.

The identification of friedelan 3 α- and 3 β-ols was rendered possible by the samples kindly supplied by Prof. H. R. Arthur, Hong Kong, to whom our thanks are due.

Dept. of Chemistry,   V. ANJANEYULU.
Andhra University,   L. RAMACHANDRA ROW.
Waltair, *July* 28, 1965.

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* Part III. The triterpenes of *Euphorbia neriifolia* Linn. latex has been published in *Curr. Sci.*, 1965. **34**, 432.

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CHEMICAL INVESTIGATION OF
ARTEMISIA SACRORUM

ARTEMISIA species have been reported to contain a number of coumarins and a flavonol methyl ether. Thus herniarin (I) is found in *A. dracunculus*,[1] scopoletin (II) in *A. afra*[2] and aesculetin dimethyl ether (III) in *A. scoparia*[3] and *A. capillaris*.[4] The flavonol methyl ether, artimisetin (IV), has been isolated from *A. absinthium* and *A. arborescens*.[5] The present study has been done using *A. sacrorum* collected from Gangotri. The plant has been reported to be used in medicine.[6] As a result of the present investigation umbelliferone (V) and genkwanin (VI) have been isolated from this plant.

I, R = OCH₃ ; R' = H

II, R = OH ; R' = OCH₃

III, R = R' = OCH₃

V, R = OH ; R' = H

IV, R = R' = OCH₃

VI, R = H ; R' = OH
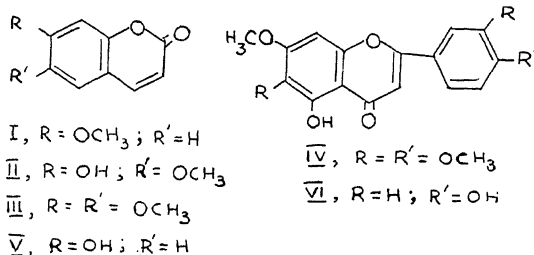
The aerial parts of the plant consisting of stem, leaves and flowers were air-dried, powdered and extracted (soxhlet) successively with petroleum ether (60–80°), ether and then with alcohol. The petroleum ether extract which contained the essential oil and some waxy matter was not investigated further. The alcohol fraction did not yield any solid material and hence was not studied. The ether extract on concentration gave a gummy residue which was macerated several times with petroleum ether to remove the last traces of fatty matter and essential oil. The residue was taken up in ether and fractionated into aqueous sodium bicarbonate, sodium carbonate (10%), sodium hydroxide (5%) soluble and neutral fractions. No solid material was obtained from the hydroxide and neutral fractions.

The sodium bicarbonate solution was acidified with hydrochloric acid and extracted with ether. The ether extract was dried (sodium sulphate) and the solvent distilled off. The residue was dissolved in the minimum quantity of methanol and allowed to stand in the refrigerator. The separated solid on crystallisation from hot water gave colourless crystals, m.p. 230°. It gave a blue fluorescence in aqueous bicarbonate and concentrated sulphuric acid and had absorption maxima at 245, 255 (shoulders) and 326 mμ. The acetate had a melting point of 140°. These properties indicated the substance to be umbelliferone and the identity was confirmed by comparison with authentic samples of umbelliferone and its acetate. The mixed melting points were undepressed in both cases.

The sodium carbonate solution was acidified and extracted with ether. From the dried ether solution the solvent was distilled off and the residue taken up in ethyl acetate. On keeping for some days the ethyl acetate solution deposited yellow crystals which were filtered off and recrystallised from the same solvent. m.p. 283°. It gave a red colour with magesium and hydrochloric acid and a brown colour with alcoholic ferric chloride. It had absorption maxima at 268 and 335 mμ in ethanol solution. Addition of fused sodium acetate produced no shift in the lower wavelength band. In the presence of sodium hydroxide the bands were observed at 267 and 395 mμ. The maxima in presence of aluminium chloride were at 280, 303, 340 and 385 mμ. These spectral characteristics[7] and other properties indicated the substance to be genkwanin and the identity was confirmed by comparison with an authentic sample.

Department of Chemistry,   V. CHANDRASHEKAR.
University of Delhi,   M. KRISHNAMURTI.
Delhi-7, *June* 14, 1965.   T. R. SESHADRI.

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A NEW LOWER GONDWANA BASIN BETWEEN NAGPUR AND KAMPTEE

DURING the course of my preliminary survey during March-April 1965, in connection with ground-water investigations around Nagpur between lat. 21° 2′ N 21° 18′ and long. 79° 4′ E 79° 30′ with reference to the dug wells, I found from a new well in the Industrial estate area along Nagpur-Kamptee road the presence of gritty sand at a depth of 30′ below the surface. With this clue and by detailed study of the dug-well sections, sandstones and green shales, similar to Kamathi formations, were found in a number of wells and the existence of a new lower Gondwana "Nara-Waroda" basin which covers an area of 110 sq. miles has been traced.

Geological formations around Nagpur are as follows :—

Soil and alluvium   ..   ..   – – – –
Trap   ..   ..   ..   – – – –

	Kamathis	Ferruginous Sandstones and shales
Gondwana forma-tions	Barakars	Sandstones with shale and coal
	Talchirs	Green shales and boulders

Unconformity

Metamorphics ..   Granitic gneiss, quartzites and limestones.

Excepting the coal-bearing Barakars, all the rock formations as given above are exposed on the surface at some place or the other in the Kamptee and Bhokara basins. Even the Kamathis the youngest formations of the Kamathi group of rocks are exposed at few places, like Kamathi, Sillewara, Bhokara and Patansaongi.

The area between Bhokara-Nara Waroda-Maunda along the N-W and S-E directions and between Nagpur and Kamathi is covered by a thick mantle of alluvium and soil. W. T. Blanford (1872) has shown the entire region as metamorphics on the basis of the exposures of granitic gneiss near Nagpur and Kamptee.

During my field-work I took some traverses and found the presence of ferruginous sandstones, grit and shales in certain wells and also from the dumps of the new wells, which are megascopically similar to Kamathi group of rocks. At only one place in the entire basin, NNW of Nari village and NNE of Nara village in a nallah, a small exposure of fine to coarse-grained sandstones and shales are present, striking WNW-ESE and dipping 15-20° SSW. The strike and dip directions are same as the strike and dip of the Kamathis exposed near Bhokara indicating possibly the extension of the Bhokara basin towards east. This new basin is named as Nara-Waroda basin (occurrence of sandstone was first noticed in a dug well near Nara village) and extends between Pioli-Nag river and Kanhan river up to the point where Nag river joins Kanhan at Saongar 30 miles east of Nagpur (ref. Map 1, given in the scale of 1″ = 10·5 miles). **The** southern limit of
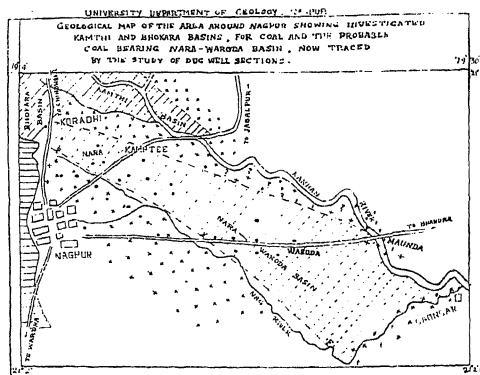
the boundary is a fault plane along Pioli-Nag river and towards south of this river metamorphics are present. The northern limit is indicated by the metamorphics occurring near Koradi, Kanhan and Maunda.

In Bhokara area, the coal-bearing Barakars are present below the Kamathis which has been proved by drilling operations, by the State Geological Department, and since this Nara-Waroda basin appears to be the extension of the Bhokara basin, I feel that Barakars exist below the Kamathis in this basin also, which can only be ascertained by test drill holes. The basin promises to be larger than the Kamathi and Bhokara basins.

Detailed work regarding the exact extent of the basin and the boundary between the Kamathis and Talchirs, and laboratory studies of the rocks are in progress along with ground-water studies and will be published in due course.

I am thankful to the U.G.C. for approving my research scheme, and to Prof. S. Kilpady for his guidance and encouragement,

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Nagpur University,
May 4, 1965.

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CHANGES IN THE GLUTAMIC AND ASPARTIC ACID LEVELS OF DETACHED WHEAT LEAVES TREATED WITH BENZIMIDAZOLE

IT is well established that the detachment of leaves from plants quickly predisposes the tissue to a series of degradative changes[1] and this is followed by an accumulation of free amino-acids, most of which are derived from proteolysis. Analysis of factors related to senescence might indicate the means of delaying the senescence. Some recent reports[3,4,6] have shown that detached leaves treated with benzimidazole remain green longer than those treated with water. Benzimidazole plays an important role in protein metabolism[5] and chlorophyll biosynthesis[7] of detached wheat leaves. Prior to a series of studies on the mechanism of action of benzimidazole in delaying the senescence of detached wheat leaves time-course experiment was undertaken to study the changes in the concentration of two important amino-acids : Glutamic and Aspartic acids.

Seven-days-old primary leaves of wheat (*Triticum diococcum*) variety Khapli were detached and floated on water and benzimidazole (50 ppm) in petri dishes placed in a growth chamber at 70° F., relative humidity 60% and a light intensity of 750 ft. candles at the surface of floated leaves. The leaves were floated under continuous illumination. The amino-acid levels were determined enzymatically by an amino-acid decarboxylase method[2] after fractionating the alcohol-soluble fraction in an ion-exchange resin.[8]

A study of Table I reveals the increase in amino-acid levels of leaves following detachment but the rate of drift being prevented by benzimidazole treatment. Perhaps by deterring proteolysis benzimidazole maintained a comparatively lower level of these two important amino-acids. Results of this experiment demonstrate an increase in amino-acid levels of detached leaves undergoing the degradative processes typical of senescence and the upward drift in the levels of these amino-acids being prevented by benzimidazole,

TABLE I
*Effect of benzimidazole on glutamic and
aspartic acid levels*

(Value expressed as μg.
per gram initial fresh wt. of leaves)

Days after detachment	Glutamic acid		Aspartic acid	
	Water	Benzi-midazole	Water	Benzi-midazole
1	166·8	123·2	118·8	78·8
3	196·8	156·0	118·8	107·6
7	428·0	348·8	121·6	112·4

Department of Botany,   D. MISHRA.
Utkal Krushi Mahabidyalaya,
Orissa University of Agriculture and Tech.,
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DEVELOPMENT OF FEMALE GAMETOPHYTE IN *EUPHORBIA PILOSA* L.

THE genus *Euphorbia* is of considerable interest since it shows a wide range of variations in the development of embryo-sac.[1,2] Besides the occurrence of monosporic, bisporic and tetrasporic types of embryo-sac development, certain of its species also show the development of more than one embryo-sac within the same ovule.[2] The present account deals with the embryo-sac development in *E. pilosa* which has not been investigated so far.

Each loculus of the superior, tricarpellary and trilocular ovary encloses a single pendulous and anatropous ovule attached to the axile placenta. A well-developed obturator is also present above each ovule. The micropyle is

formed by the outer integument only and the cells of the obturator are in close contact with the nucellar beak.

In more than fifty ovules a single deep-seated megaspore mother cell has been observed but in nearly twenty ovules presence of two to three megaspore mother cells has been recorded (Figs. 1, 2). Each megaspore mother
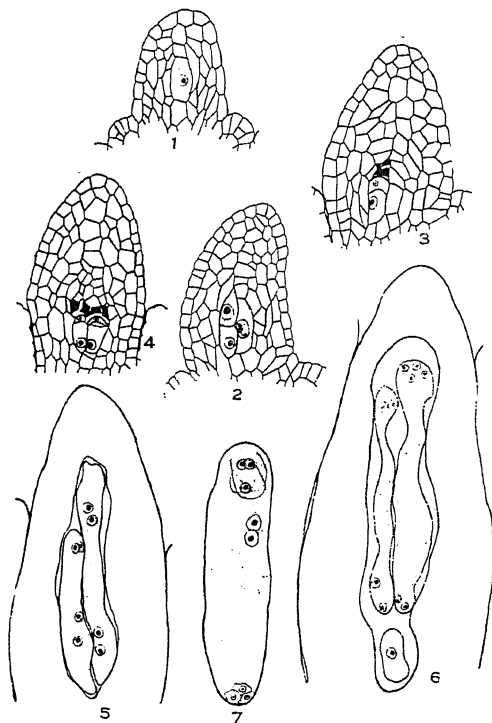
FIGS. 1-7. *Euphorbia pilosa* L. Figs. 1-2. A portion of ovule showing a single and three deep-seated megaspore mother cells respectively. Figs. 3-4. A portion of ovule showing linear and T-shaped arrangement of Megaspores. Fig. 5. L.s. nucellus showing twin embryo-sacs at the same stage of development. Fig. 6. L.s. nucellus showing three embryo sacs at different stages of development. Fig. 7. An organized embryo-sac. All Figs., × 176.

cell after meiosis forms a tetrad of megaspores which may be arranged in a linear or T-shaped manner (Figs. 3, 4). It is the chalazal megaspore which develops further and the other three degenerate. The development of the embryo-sac follows the *Polygonum* type. The egg apparatus consists of two synergids and an egg (Fig. 7). The polars in majority of cases lie close to the egg apparatus and the three antipodals soon degenerate.

A few cases have been observed where more than one developing embryo-sac are present in an ovule. These embryo-sacs may be at the

same or different stages of development (Figs. 5, 6). Figure 6 also shows a six-nucleate embryo-sac in which four nuclei are at the micropylar end and only two at the chalazal end. This suggests that the two chalazal nuclei have not undergone division yet. Similar cases of the existence of temporary six-nucleate condition have been reported also in other species of *Euphorbia*.[3,4]

Department of Botany,   R. P. SINGH.
B.R. College, Agra,   JAWAHAR LAL JAIN.
March 25, 1965.

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ECO-PHYSIOLOGICAL STUDIES ON ARID ZONE PLANTS

I. Phytotoxic Effects of Aqueous Extract of Mesquite, *Prosopis juliflora* DC.

THE production of phytotoxic substances have been reported in a large variety of plants and plant parts.[1,2] Evidences have also been put forth suggesting a possible role of these inhibitors in the interaction of different species as also in competition for survival.[3] *Prosopis juliflora* is a drought-resistant, rapidly-growing plant of recent introduction in the North-Western Indian desert. The plant grows luxuriantly on loose sandy soils and exhibits diverse growth forms ranging from dense thickets of small shrubs to large trees. Although the advantages derived from this plant are very many including its sand-binding capacity and fuel value, the possibilities that the plant may prove obnoxious in the near future are also clearly discernible from the fact that the plant has already started forming pure communities with no vegetation underneath it, and at specific places also stands favourably in competition with the crop.

The plant owes largely to livestock that acts as one of the best agencies for its distribution. The pods are eaten away specially by goats and the seeds coming out of the alimentary canal are rendered more favourable for easy germination. As a result, more and more plants are encroaching fertile areas every year. The reasons for the successful adaptation of this plant may be manifold including certain distinct advantageous characteristics in its eco-physiological behaviour. The observations

reported herein form a part of the study on the eco-physiological behaviour of this plant.

As stated earlier it has been the experience of the authors that under the shade of this noxious tree practically very little or no vegetation exists. Experiments were carried out in order to ascertain whether the plant or plant parts contain certain inhibitors. For this purpose 20 gm. of leaves and an equal amount of mature pods were crushed separately in 100 ml. of water each and kept overnight. The aliquots thus formed were centrifuged and 10 ml. of the same were poured into petri dishes containing blotting-paper and seeds of various plant species (Table I). Prior to transference into petri

spp. are found growing near the bushes of mesquite. Not much difference was noticed whether the aliquot was used prior to or after it had been autoclaved at 15 p.s.i. for 20 minutes. This probably suggests that the germination-inhibiting factor present in the aliquot might be water-soluble and heat-resistant.

Further in order to ascertain the minimum concentration of the aliquot that would restrict germination of the seeds of a particular plant species, the seeds of *Merremia ægyptica* were grown in various dilutions of the original stock solutions (Table II). From the results two possibilities suggest themselves. First it is

TABLE I

Effect of leaf and fruit extract on germination of various plant species
Germination period—four days

Family		Species	Percentage germination		
			Control	Leaf extract	Fruit extract
Compositæ	..	Chrysanthemum	99–100	5–9	2–3
		Lettuce	98–100	3–4	0–1
		Marigold	99–100	10–15	0–1
Convolvulaceæ	..	*Merremia ægyptica*	100	0–0	0–0
		Merremia quinqefolia	100	0–2	0–1
Gramineæ	..	Wheat	100	15–20	3–5
Pedaliaceæ	..	Sesamum	100	20–25	5–10
Leguminosæ	..	*Indigofera tinctoria*	100	30–40	20–30
		Tephrosia incana	100	70–80	50–60
		Cicer	100	10–15	5–10

dishes the aliquots were always tested for determination of pH. The pH of the leaf and mature fruit extract ranged between 4 to 4·4 and 5 to 5·5 respectively. Any lower concentration of the aliquots, if required, was made by appropriate dilution of the 'stock' solutions. Seeds for the control set were grown in distilled water. Before placing the seeds for germination, the 'hard' seeds, especially those belonging to Leguminosæ and Convolvulaceæ, were subjected to such physical or/and chemical treatments that would ensure cent per cent. germination in control (an account of these treatments is intended to be published in a further communication).

The results presented in Table I clearly demonstrate that the leaf and mature fruit extracts of mesquite are capable of inhibiting germination of seeds of most of the plants tested. Seeds of only *Tephrosia* and *Indigofera* exhibit appreciable germination while still in the leachate. It may be interesting to record that in natural habitats also plants of *Tephrosia*

TABLE II

Effect of various dilutions of leaf and mature fruit extract on germination of Merremia ægyptica. Concentration of extract— 20 gm. fresh weight/100 ml. water

Dilution	Percentage germination	
	Leaf extract	Fruit extract
1 : 1	0–0	0–0
1 : 2	0–0	0–0
1 : 4	0–2	0–2
1 : 8	70–80	0–5
1 : 16	90–100	90–100

apparent that upto four times dilution of the stock solutions no seed tested would exhibit germination. Secondly, in comparison with the leaf extract the fruit extract appears to be more potent in bringing about inhibition. It may be possible that inhibiting factor from falling leaves and fruits may render the soil beneath a tree unfavourable for seed germina-

tion as indicated above. It remains, however, to be explored whether such leachate in nature is really effective in the manner suggested.

Botany Department,   N. SANKHLA.
University of Jodhpur,   MISS D. BAXI.
Jodhpur, *March 31, 1965.*   U. N. CHATTERJI.

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NOTE ON VITAMIN C CONTENT IN DIPLOID AND TETRAPLOID CAPSICUM

THE pungent principle of Capsicum (chilli or red pepper) is capsaicine found in the placental tissue—but the more important nutritive value of Capsicum lies in the high vitamin C content of the ripe fruit which is much higher than in tomatoes. In this experiment ten varieties of chillies, grown in the Regional Research Laboratory, Jammu, were analysed for the vitamin C content to see the variation in the different types. At the same time tetraploids of these varieties were produced by treating them with ·2% colchicine and their vitamin C content also estimated as ascorbic acid. Increase of vitamin C as a result of induced tetraploidy has been reported in cabbage[2] and tomatoes.[1]

The analysis of ten diploids and their corresponding tetraploids is given in Table I.

TABLE I

Vitamin C content in diploid and tetraploid Capsicum

Sl. No.	Name of variety	Vitamin C mg./100 g.		Increase	Percentage increase
		diploid	tetraploid		
1	Bull Nose	35·4	40·6	5·2	15
2	California Wonder	44·5	130·0	85·5	192
3	Chinese Giant	91·2	110·5	19·3	21
4	Jammu Conical	64·9	66·2	1·3	2
5	do. Long	83·0	83·8	0·8	1
6	do. Medium Broad	55·9	96·6	40·7	73
7	do. Medium Long	49·2	154·0	104·8	213
8	do. Long Thin	47·8	64·0	16·2	34
9	do Small	82·1	130·0	47·9	58
10	Kashmir Large	47·9	111·0	64·1	134

The range of variation of the vitamin C content in the diploids is from 35·4 to 91·2 mg./100 g. and in the case of tetraploids the range is from 40·6 to 154·0 mg./100 g.

My grateful thanks are due to Dr. E. K. Janaki Ammal for her guidance and to Dr. K. Ganapathi, Director, for his keen interest.

Regional Research   SWARAN RAMPAL.
    Laboratory,
Jammu, *April 25, 1965.*

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FEMALE GAMETOPHYTE AND ENDOSPERM IN *LAGENANDRA OVATA* THW.

THE necessity of critical studies on the embryology of Araceæ has been repeatedly stressed.[1-5] While a great deal of embryological investigation has been accomplished in some genera, there are others which need study. The present work deals with Lagenandra.

Lagenandra ovata. Thw. is a monœcious marshy herb with a slender spadix. The flowers are unisexual and both the male and female flowers are devoid of perianth. Each male flower has 1-2 stamens and the sessile anthers are 2-4 locular opening by terminal pores. There are many female flowers, spirally disposed at the base of the spadix. Ovary is one-celled, free and with peltate or discoid stigma. Ovules are orthotropous, basal and 1 or 2 in each ovary. Fruit is berry.

The ovule is bitegmic and tenuinucellate. Both the inner and outer integuments are concerned in the formation of the micropyle. During the early development the two integuments appear to be different in size. The inner integument is two cell layers in thickness in most part except at the micropylar region where it is 4-5 layers thick. The outer integument is made of 2 cell layers in thickness except at the base. The inner layer of the inner integument organises into an endothelium in which the constituent cells have radial walls longer than the others.

A hypodermal archesporial cell is distinguished in the nucellus (Fig. 1) and it directly functions as the megaspore mother cell (Figs. 2 and 3).

The laterally placed nucellar cells thin out and finally degenerate when the embryo-sac is fully formed, while those cells of the nucellus towards the apex persist in the form of cap (Figs. 5 and 6). This results in the sides of the embryo-sac coming in direct contact with the endothelium. The cells of the nucellar

cap become much conspicuous and longitudinally elongated (Fig. 7). Often the nucellar cap undergoes periclinal divisions giving rise to a two-layered cap (Figs. 3 and 7). The
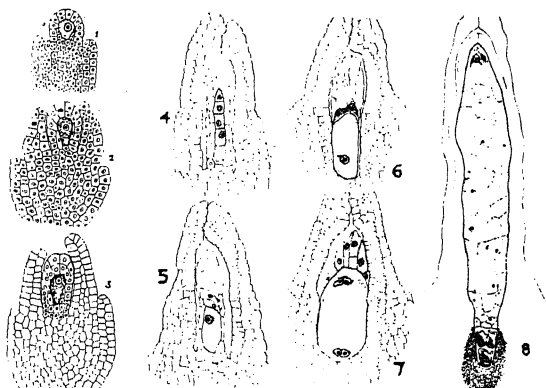
FIGS. 1-8. Fig. 1. L.s. of ovule primordium showing archesporium. Figs. 2-3. Archesporia with sporogenous cells. Fig. 4. Megaspore mother cell forming a linear tetrad. Fig. 5. Functioning megaspore. Fig. 6. Functioning megaspore and the degenerating megaspores. Fig. 7. 4-nucleate embryo sac. The nucellar cap cells have elongated and the lateral cells of nucellus have degenerated. Fig. 8. Early stage of cellular endosperm. Note the increased size of antipodals. The nucellar cap degeneratad (Figs. 1-7, ×115; Fig. 8, ×30).

nucellar cap disintegrates and finally disappears during the development of the endosperm.

The megaspore mother cell undergoes the usual meiotic divisions to form a linear tetrad (Fig. 4). The chalazal megaspore usually functions (Fig. 5) and gives rise to the embryo-sac while the remaining 3 megaspores degenerate and disappear.

The functioning megaspore undergoes three successive divisions giving rise to an 8-nucleate female gametophyte of *Polygonum* type.[2] The polar nuclei lie at the central portion of the embryo-sac and the secondary nucleus formed after fusion lies below the egg and is separated from the antipodal cells by a large vacuole. The antipodals enlarge becoming prominent during the endosperm development. The entry of the pollen tube is porogamous and double fertilisation is accomplished. The embryo-sac becomes considerably elongated after fertilisation.

The antipodals are placed at the downwardly elongated base of the embryo-sac. While the endosperm is being formed, the antipodals become active, its nuclei enlarge in size and the cytoplasm becomes granular. The antipodals divide to form 4 to 6 cells. They are differentiated by the deep staining and are

sharply separated from the endosperm cells placed above them. Occasionally, along with the increase in the number of antipodal cells, there is an increase in the number of nuclei per antipodal cell.

The primary endosperm nucleus divides before the zygote. The first wall is transverse forming 2 chambers. Subsequent divisions take place in both the chambers. The walls formed at the end of first few divisions are usually transverse. Later divisions are irregular and numerous cells are finally formed. Thus in *Lagenandra ovata*, the endosperm formed is of cellular type.

The presence of cellular endosperm is reported in 12 out of the 25 species of Araceæ thus far investigated, *Lagenandra ovata* is yet another instance. Much of the early work on Araceæ with regard to the formation of endosperm is of doubtful nature and needs reinvestigation.

University Department of   T. K. B. PANICKER.
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Calicut-8, *March* 22, 1965.

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DIFFERENTIAL RESPONSE OF TWO VARIETIES OF COWPEA (*VIGNA SINENSIS* ENDL.) TO GA AND IAA

INTERSPECIFIC and intraspecific variations in response to GA application are well known.[1] Intraspecific variations in response is more striking in species having tall and dwarf varieties. The tall varieties respond little to GA, whereas dwarfs respond by assuming the tall phenotype. This was first reported in peas[2] and later confirmed in maize.[3]

However, no such intraspecific variations in response to IAA by intact plants have been reported so far. In general, auxins have little effect on cell elongation in intact plants.

The present work was designed to study the varietal differences in the trailing habit in response to application of GA and IAA. Different varieties of cowpea were chosen for the investigation.

Pure line seeds of different varieties of cowpea were obtained from the Agricultural College, Vellayani, of which ECR 1548 is a comparatively bushy variety and EC 455 is a trailing variety. Response of other varieties is not considered in this communication. Seeds were sown in 12″ unglazed earthen pots filled with 3 : 1 mixture of field soil and farm-yard manure. Three weekly sprays of 50 ppm GA or 10 ppm IAA were given from the 8th day of sowing according to the treatments. Controls received distilled water spray. Height of the main axis was measured on the 30th day. The results are shown in Table I.

TABLE I

Height of the main axis in cm. (average of four replicates)

Treatments	Var. ECR 1548 (bushy)	Var. EC 455 (trailing)
Control ..	22·8	123·2
Weekly 50 ppm GA ..	75·5	123·0
Weekly 10 ppm IAA ..	21·8	40·5
	S.E. ± 1·75	

The differential effect of GA in inducing trailing habit in the bushy variety (Fig. 1) and in not having any effect on the trailing variety (Fig. 2) is in agreement with the known mode of action of GA. But the effect of IAA in inhibiting the growth of trailing variety (Fig. 3) while having little effect on bushy variety (Fig. 4) has not hitherto been reported.

Growth appears to be controlled by complex interactions of endogenous auxins, gibberellins and a growth-inhibiting factor. GA is considered to reverse the effect of the inhibitory system.[1] It appears that this effect of GA may depend on the relative concentration of endogenous auxins or possibly on some effective ratio between endogenous gibberellins and endogenous auxins. When this hormonal balance is upset by an increase in the endogenous level of either gibberellins or auxins, the growth pattern of the plant alters. In the trailing variety, the inhibitor was either absent or inactive due to higher endogenous gibberellin content. Effect of GA in inducing trailing habit in the bushy variety by internode elongation can be explained by assuming a resultant enhancement of the level of gibberellins in the plant. Effect of IAA in

retarding the growth of the trailing variety may be due to an increase in the level of auxins and a fall in the relative level of gibberellins in the plant. Recently, IAA is reported to have inhibited the GA-induced elongation of rice leaf
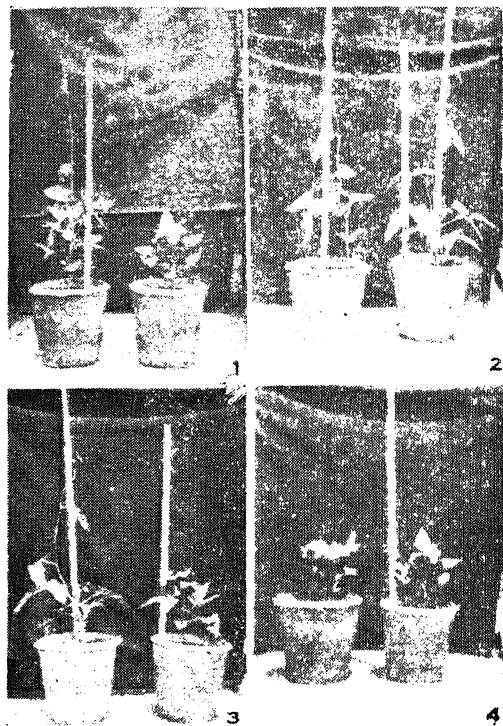
FIGS. 1-4. Fig. 1. Effect of GA on bushy variety. Fig. 2. Effect of GA on trailing variety. Fig. 3. Effect of IAA on trailing variety. Fig. 4. Effect of IAA on bushy variety. V_1 = Bushy variety; V_3 = Trailing variety ; T_1 = Control ; T_3 = Weekly spray with 50 ppm GA ; T_4 = Weekly spray with 10 ppm IAA.

sheath.[4] It is assumed that a certain balance should be maintained between endogenous level of gibberellins and auxins for the effective action of GA. However, further studies on the interactions of gibberellins and auxins in different varieties of intact plants have to be carried out to come to a definitive conclusion.

My thanks are due to Prof. P. Kumara Pillai, Agricultural College and Research Institute, Vellayani, where this work was carried out.

Rubber Res. Inst. of India,   M. R. Sethuraj.
Kottayam-9, Kerala, *May* 22, 1965.

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INDUCING AERIAL ROOTING IN TOBACCO BY NAPHTHALENE ACETIC ACID SPRAY

WHILE working on the problem of suppression of suckers by growth regulators some interesting side effects of naphthalene acetic acid on the flue-cured tobacco plant (*N. tabacum*, variety Virginia Gold) were observed. The plants were topped soon after the opening of the first flower and naphthalene acetic acid (NAA) was sprayed as 500 ppm solution in water prepared from a stock solution of 2% NAA in triethanolamine on the top 6 leaves at 20 ml. per plant. Within 24 to 48 hours of spraying the leaves receiving the spray showed an epinastic curvature due to faster growth of the upper side of the stalk compared to the lower side. Sastry *et al.* (1957) also observed such a curvature when NAA was applied on the cut stump after topping in tobacco. The influence was passed down progressively to the lower leaves evidently in response to gradual transport of the chemical from the sprayed top leaves to the bottom leaves. In about a fortnight, however, the influence passed off and the leaves including those which received the spray regained normal position and shape. When the lower leaves alone were sprayed, only the leaves sprayed showed the curvature and the top ones remained unaffected. This clearly showed the presence of basipetal transport of naphthalene acetic acid in the tobacco plant.

Another effect of spray was the appearance of innumerable rudimentary roots along the stem after about 2 weeks from spraying. These appeared in longitudinal streaks starting from the 4th or 5th internode below the level of topping and ran through 6 to 7 internodes leaving the lower position of the stem without any roots. Raguini (1955) has also observed that application of two drops of NAA on the cut stump of tobacco favoured rooting in the top 10 nodes and internodes. Occasionally in the present case, these roots spread over larger areas in some internodes but still the longitudinal arrangement of the roots was clearly visible. The roots just protruded out and showed positive geotropism by bending downwards but did not grow any further. But when covered with moist soil and sand mixture for about 2 weeks, these rudimentary roots developed into a profuse branched root system each elongating to 5 to 10 cm. in length (Fig. 1).

Roots were also found to occur on the stems of untopped plants when sprayed with NAA of the same concentration indicating absence of any dominant role of the terminal bud in this respect.
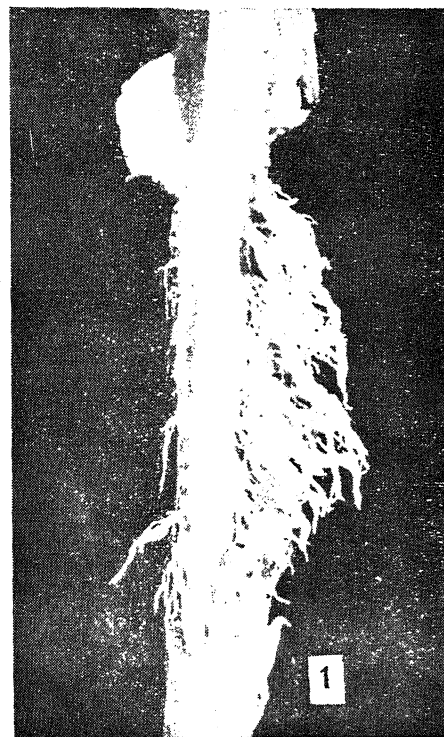

FIG. I. Development of aerial roots on stem in region covered with moist soil. The upper internode which was not covered showed only rudimentary growth of root.

A plant which was sprayed twice with 20 ml. of 125 ppm NAA at 10 days interval was cut into a number of segments after 23 days from spraying (*i.e.*, after the rudimentary roots had appeared) and planted in soil. Some axillary branches (suckers) growing on the sprayed plants were also similarly planted. All the stem cuttings and suckers got established and began to grow vigorously as new plants.

The induction of aerial rooting would be of great utility and to best advantage in propagating valuable breeding materials such as the monosomics of tobacco, interspecific hybrids and genetic stocks, where perpetuation and continuous maintenance of true to stock material all through the year is a necessity. The vegetative propagation would eliminate the elaborate process of raising seed derived offsprings and their screening at later stages.

Our thanks are due to Dr. D. M. Gopinath for his keen interest in this work.

Plant Physiology Section,   M. BANGARAYYA.
Central Tobacco Research   N. L. PAL.
  Institute,
Rajahmundry-1, *April* 20, 1965.

1. Raguini, J. R., *Phillip. Agric.*, 1955, **38**, 536.
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DISCOVERY OF *HAPLOMITRIUM HOOKERI* (SMITH) NEES IN ASIATIC FLORA

RECENTLY Udar and Chandra[2] have reported *Calobryum* from Darjeeling in Eastern Himalayas. This first Indian representative of the order Calobryales has since been discovered to be a new species of *Calobryum*, *C. indicum* Udar et Chandra.[3] The only other genus included in this order is *Haplomitrium* typified by *H. hookeri* (Smith) Nees. Schuster,[1] however, regards *Calobryum* to be cogeneric with *Haplomitrium*—an issue which, we feel, has still to be finally settled.

So far, *H. hookeri* has been recorded only from North America, Europe and Spitsbergen. The authors have found *H. hookeri* (Fig. 1)
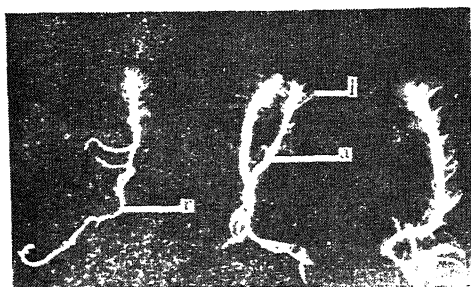

FIG. 1. Three female plants of *Haplomitrium hookeri* showing creeping rhizome (*r*) without rhizoids, erect axis (*a*) bearing three ranked leaves (*l*), × 3·4.

in a collection of liverworts brought by Drs. B. B. Sharma and D. D. Awasthi from Darjeeling. This discovery constitutes the first Asiatic record which not only extends the distributional range of this taxon, but is also significant in the plant being recorded from the same locality from where *C. indicum* was collected. There is no other similar record of the occurrence of these two genera in a common locality. A detailed study of the Indian plants of *H. hookeri* from morphological and phytogeographical point of view is in progress and will be published elsewhere.

Department of Botany,   RAM UDAR.
University of Lucknow,   VINOD CHANDRA.
Lucknow (India), *April* 29, 1965.

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THREAD BLIGHT OF WATER HYACINTH

WATER hyacinth, *Eichhornia crassipes,* is a notorious aquatic weed, which has cost man much labour and money in the countries where it has appeared. It is known to impede navigation, choke waterways and irrigation channels and also afford breeding places for the mosquito. In West Bengal and some other parts of India, it is considered a menace in paddy fields and the farmer is compelled to erect barricades to prevent the weed from entering the fields through irrigation. Mechanical removal and chemical methods are advocated, but, for one reason or other, none of the methods has so far been quite successful in eradicating the weed.

In recent years, biological control of many weeds through their natural enemies has been receiving increasing attention. At the instance of the U.S. Department of Agriculture, work in this direction was initiated at this Institute in 1962 to conduct surveys for natural enemies of several weeds including water hyacinth. In the course of this work, a thread blight affecting water hyacinth was observed in Calicut (Kerala) in October 1964.

The infection was more evident in dense stands of the weed and death of the plants occurred in irregular patches. Leaves, petioles and all aerial parts of the plants were affected. The affected plants had a pale unthrifty appearance in the initial phase of the disease, while in an advanced state of infection, the affected parts or the entire plants had turned brown or dark brown and necrotic. These were overrun by thick white radiating strands of mycelium. The plants rotted or dried up depending upon the prevailing weather conditions. No fruiting bodies of the fungus were observed.

Examination of the infected tissues revealed the presence of scant, branched, septate, hyaline hyphæ bearing clamp connections. The rhizomorphic strands were composed of hyphæ of similar morphology but of variable dimensions, anastomosing with each other.

The fungus was readily obtained in pure culture. Its pathogenecity to water hyacinth was established by satisfying the requirements of Koch's postulates. It was observed that rapid spread of the mycelium over the host precedes the death of the underlying tissues. Figure 1 illustrates water hyacinth plants infected by a culture of the fungus in the
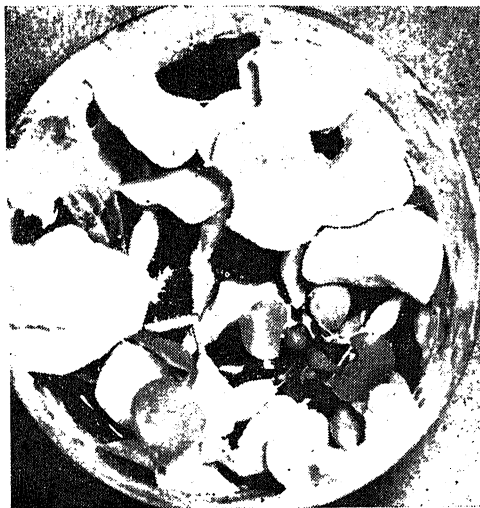

FIG. 1. Water hyacinth plants infected by a culture of the fungus in the laboratory. Plants photographed 24 days after inoculation. The three apparently healthy looking leaves were later destroyed by the fungus mycelium.

laboratory (plants photographed 24 days after inoculation). The fungus has been induced to produce fruiting bodies (Fig. 2). Based on the characteristics of the fruiting bodies the fungus has been identified as *Marasmiellus inoderma* (Berk.) Sing.

In India, water hyacinth has been known to be susceptible to attack by a few fungi: *Cercospora piaropii* Tharp.[2] and *Fusarium equiseti* (Corda) Sacc.[1] *Rhizoctonia solani* Kuehn. and *Myrothecium roridum* Tode ex Fr. have also been observed to occur on this host in a few parts of this country (unpublished data). Damage inflicted by *C. piaropii* on water hyacinth is negligible. In the case of the disease caused by *F. equiseti*, Banerjee[1] concluded that

the damage caused was unimportant and the progress of infection very slow owing to the high power of resistance of the host. *R. solani* and *M. rorium* can often cause considerable damage to the weed, but are of little utility in biological control of the weed in view of their wide host range. In infection by *Marasmiellus inoderma*, under the conditions of the infection experiments conducted in this laboratory, the fungus mycelium has been observed to cover the weeds very rapidly. This appears to be a distinct advantage in itself, and tests with the fungus are in progress to determine whether it can be utilized at all in biological control of the weed.
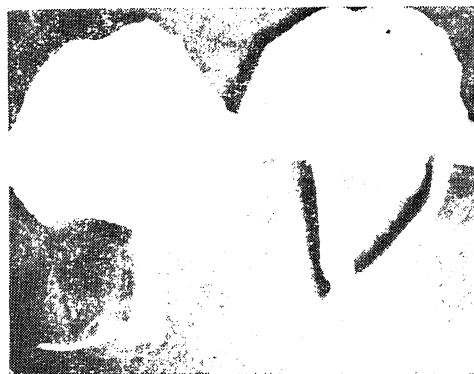

FIG. 2. Fruiting bodies of the fungus—*Marasmiellus inoderma*.

This preliminary note is intended to record the occurrence of the fungus as a pathogen of water hyacinth. Results of the investigations in progress will be published in detail in due course.

Commonwealth Institute of   T. R. NAG RAJ.
    Biological Control,
Indian Station, P.B. No. 1503,
Bellary Road, Bangalore-6, *June* 24, 1965.

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2. Thirumalachar, M. J. and Govindu, H. C., *Sydowia*, 1954, **8**, 343.

REVIEWS AND NOTICES OF BOOKS

Error Propagation for Difference Methods. By Peter Henrici. (John Wiley and Sons, Inc., New York and London), 1963. Pp. vi + 73. Price. $4.95.

This book is a sequel and companion to the earlier work of the author entitled "Discrete Variable Methods in Ordinary Differential Equations" (Wiley, 1962).

This present work concentrates on the analogous results for the integration of systems by multi-step methods—through which the theory of error propagation will finally appear as a well-rounded whole.

The treatment given here is essentially independent from the treatment of the one-dimensional case. The general theory is applied to numerical integration of the equations of the two-body problem and also to a related simpler problem. The results are unexpected, but fully confirmed by numerical experiment.

C. V. R.

Fundamentals of Ultrasonics. By J. Blitz. (Butterworths and Co. Ltd., London), 1963. Pp. ix + 214. Price 35 *sh.*

This book will serve as a general text-book for the Physics student, and is intended for students in the final years of University Degree and Diploma in Technology courses, as well as for all who require an introduction to the physical aspects of ultrasonics.

The following is a list of the eight articles contained in this volume: Introduction; General Principles of the Propagation of Low Amplitude Waves; Ultrasonic Generators and Receivers; Low Amplitude Propagation in Gases; Low Amplitude Propagation in Liquids; Low Amplitude Propagation in Solids; Low Power Applications of Ultrasonics; High Energy Ultrasonic Waves.

C. V. R.

Reaction Heats and Bond Strengths. By C. T. Mortimer. (Addison-Wesley Publishing Company, Inc., U.S.A., and London), 1963. Pp. xii + 230. Price $5.00.

In this book the variations in the heats of particular types of reaction are considered. These include, for example, hydrogenation and polymerization of olefinic compounds; the dislocation of organic and organo-metallic compounds and also of molecular-addition compounds. An attempt has been made to interpret these variations in simple terms and also to indicate the great wealth of information which can be gained about the strengths of chemical bonds from the measurement of heats of chemical reactions.

C. V. R.

The Case Against the Nuclear Atom. By Dewey B. Larson. (North Pacific Publishers, P.O. Box 5044, Portland 13, Oregon), 1963. Pp. vii + 139. Price $4.50.

The scope of the book is indicated by the list of the chapter headings given below: Introduction; The Nucleus; The Electrons; Particle Problems; Postulates Unlimited; Other Names for Roses; Electric Questions; Pictures *vs.* Models; The Philosophical Aspect; Facts and Fancies; The Role of Clear Thinking; Where Do We Go from Here?

C. V. R.

Magneto-Fluid-Dynamics (*Basic Equations and Waves*). By P. L. Bhatnagar. (Annamalai University), 1964. Pp. 104.

This book represents a course of three extension lectures delivered by the author in February 1963 at the Annamalai University in response to the invitation received from Prof. V. Ganapathy Iyer and Annamalai University.

The following is the list of contents of the lectures delivered by the author: Introduction; Electro-magnetic Field Equation for a Moving Medium; Pondermotive Force acting on a Moving Electrically Conducting Medium; Electro-magnetic Boundary Conditions; Magnetic Induction Equation and Applicability of MFD; Equations of Motion; Orders of Magnitude; Vorticity and Circulation; Virial Theorem; Realization of Magnetohydrodynamic Wave (MHW); Small Amplitude Waves in a Real Conducting Fluid; Non-linear Waves: Ordinary Disturbance Waves; Non-linear Waves: Shock Waves; Pinch Effect.

C. V. R.

Principles of Telegraphy. By N. N. Biswas. (Asia Publishing House), 1964. Pp. x + 185. Price Rs. 12·50.

The titles of the chapters contained in this volume are as follows: Telegraph Codes; Telegraph Instruments and Relays; Telegraph Circuits; Teleprinter and Telex; Facsimile and Picture Telegraphy; Submarine Cable Telegraphy; Voice Frequency Telegraphy.

Although the book has been written primarily for B.E. Degree course in Telecommunication and Electrical Engineering of a University, it will be found suitable for the Graduateship examination of Professional Institutions.

C. V. R.

Geometry of Manifolds (Volume XV of Pure and Applied Mathematics). Edited by P. A. Smith and S. Elienberg. Authors : Richard L. Bishop and Richard J. Crittenden. (Academic Press, New York and London), 1964. Pp. ix + 273. Price $ 10.50.

This book will be found to be of great interest by graduate students in the field.

The scope of this volume is indicated by the titles of the chapter headings given below : 1. Manifolds ; 2. Lie Groups ; 3. Fibre Bundles ; 4. Differential Forms ; 5. Connexions ; 6. Affine Connexions ; 7. Riemannian Manifolds ; 8. Geodesics and Complete Riemannian Manifolds ; 9. Riemannian Curvature ; 10. Immersions and the Second Fundamental Form ; 11. Second Variation of Arc Length. *Appendix* : Theorems on Differential Equations.

C. V. R.

Man Microbe and Evolution. By Dr. S. C. Seal. (Printed and published by Dr. S. C. Seal at the Roxy Printing Press, New Delhi), 1964. Pp. ii + 103 ; viii. Price Local : Rs. 5 ; Foreign $ 1.50 ; 10 *sh.*

The titles of the chapters contained in this book are as follows : Introduction ; The Living Cell ; The Bacterial Cell ; Bacterial Genetics ; Certain Characteristics of Microbe ; Microbe in Relation to Man ; The Origin and Evolution of Microbe ; Evolution of Sex ; Probable Origin of Life and Concluding Remarks.

C. V. R.

Solid State Physics—*Advances in Research and Application* (Vol. 15). Edited by Fredrick Seitz and David Turnbull. (Academic Press, New York and London), 1963. Pp. xvi + 505. Price 118 *sh.*

Volume 15 of this well-known series contains the following five contributions by eminent authors in this field : 1. The Changes in Energy Content, Volume, and Resistivity with Temperature in Simple Solids and Liquids, by G. Borelius ; 2. The Dynamical Theory of X-Ray Diffraction, by R. W. James ; 3. The Electron-Phonon Interaction, by L. J. Sham and J. M. Ziman ; 4. Elementary Theory of the Optical Properties of Solids, by Frank Stern ; 5. Spin

Temperature and Nuclear Relaxation in Solids, by L. C. Hebel, Jr.   C. V. R.

Bacterial Endotoxins. Edited by Maurice Landy and Werner Braun. (The Rutgers University Press, New Brunswick, New Jersey, U.S.A.), 1964. Pp. xvi + 691. Price $ 12.00.

The meeting which formed the basis for this volume took place at the Institute of Microbiology, Rutgers University, New Brunswick, New Jersey, on September 4, 5 and 6, 1963.

The subject-matter has been dealt with under eight parts. Their titles and the number of papers presented by the contributors are as follows : Part I. Chemistry : Ten ; Part II. Pharmacological Effects I : Five ; Part III. Pharmacological Effects II : Eight ; Part IV. Immunological Phenomena : Eight ; Part V. Effects on Host Resistance to Infection : Seven ; Part VI. Tolerance versus Hyperreactivity : Eleven ; Part VII : Modes of Action I : Six ; Part VIII. Modes of Action II : Six.

C. V. R.

Patterns in the Balance of Nature. By C. B. Williams. (Academic Press, London), 1964. Pp. vii + 323. Price 60 *sh.*

The object of this book is to draw attention to a large number of problems in statistical ecology, and particularly in population balance, which have in common the property of being expressible as frequency distributions, and so have a mathematical pattern. The central theme is the pattern in which all the species in an association are balanced, irrespective of the particular position of one or two selected species.

The survey is wide rather than detailed, and in most cases final conclusions are not reached, and often not attempted. There can be no doubt, however, that some of the concepts, such as that of a measurable diversity, are valuable tools in the study of population ecology. By concentrating on the pattern of balance, it is possible to see relations between ecological problems which otherwise appear unrelated.

C. V. R.

Introduction to Lattice Theory. By Gabor Szasz. (Academic Press, New York and London), 1964. Pp. 229. Price $ 8.50.

The study of this volume requires no more than a rudimentary knowledge of set theory. Nevertheless, it is advantageous if the reader has a good knowledge of abstract algebra,

The subject-mater in this book is dealt with in ten chapters whose titles are as follows : Partly Ordered Sets ; Lattices in General ; Complete Lattices ; Distributive and Modular Lattices ; Special Subclasses of the Class of Modular Lattices ; Boolean Algebras ; Semimodular Lattices ; Ideals of Lattices ; Congruence Relations ; Direct and Subdirect Decompositions.

At the end of each chapter, some exercises are given to help the reader attain the necessary skill for handling the theoretical material. Hints to the solution of the more involved exercises are found at the end of the book.

C. V. R.

Germfree Life and Gnotobiology. By Thomas D. Luckey. (Academic Press, New York and London), 1963. Pp. xii + 512. Price $ 9.50.

This volume treats the theory and general aspects of germfree research and provides a summary of germfree work in all phyla, thus presenting an over-all picture of the subject. The following is a list of the titles of the chapters contained in this book : Theory and General Aspects of Germfree Life and Gnotobiology ; Phylogenetic Development of Germfree Research ; Germfree Animal Techniques ; Nutrition of Germfree Animals ; Characteristics of Germfree Animals ; Gnotophoric Animals.

The extensive bibliography will serve as a guide to the literature in the field.

C. V. R.

Handbook of Analytical Design for Wear. Editor C. W. MacGregor ; Author ; R. G. Bayer and T. C. Ku. (Plenum Press, New York), 1964. Pp. 97. Price $ 12.50.

The material contained in this Hand-Book was prepared by members of the staff of the Physical Technology Section, General Products Division, Development Laboratory, International Business Machines Corporation, Endicott, New York. The names of the contributors to this volume are : W. C. Clinton ; R. A. Schumacher ; J. L. Sirico ; A. R. Wayson and C. W. Nelson.

The design procedures presented in this book show how to relate the wear performance of a sliding mechanism to : the loads which that mechanism experiences, the geometry of the mechanism, and the properties of the material used for that mechanism. The basic feature of these procedures is that they are *analytic* and of *broad* application. They apply to virtually all sliding mechanisms such as : a cam and its follower ; a journal bearing ; a bar sliding against a guide, etc.; and to a large

group of materials such as : plastics, sintered metals, and bulk and layered materials.

In content the book is basically a design manual intended for use by design engineers and assumes a knowledge of basic mechanical engineering and algebra. Divided into three parts, the first section is devoted to a short summary of the model upon which the design procedures are based ; the second presents step-by-step discussion of the procedures illustrated by detailed examples. The third section is a compilation of expressions and data germane to the design procedures and intended to make the book self-sufficient.

C. V. R.

Mathematics in Science and Engineering: Vol. 10. **Optimum Design of Digital Control Systems.** By Julius T. Tou. (Academic Press, New York and London), 1963. Pp. xi + 186. Price $ 7.00.

The material presented in this book is based, in the main, upon the research carried out by the author and his co-workers during the past several years. This volume is intended to be of use both as a reference book for computer and control engineers and as a supplementary text-book for courses in optimization techniques and modern control theory. As a background to this book, it is assumed that the reader has adequate preparation in college mathematics and an introductory course on modern feedback control systems.

The subject-matter is dealt with in nine chapters whose titles are as follows : Introduction ; General Principles of Optimum Design ; Optimum Control for Multivariable Processes ; Optimum Control for Processes with Inaccessible State Variables ; Optimum Estimation of State Variables ; Optimum Control for Random-Parameter Processes ; An Illustrative Example ; Design for Optimum Quantization ; Time Responses for Optimum-Quantized Systems.

C. V. R.

Elements of Tensor Calculus. By A. Lichnerowicz. (Methuen & Co. Ltd.; New York : John Wiley & Sons, Inc.), 1962. Pp. viii + 164. Price 21 *sh.*

The subject-matter in this book is dealt with in two parts, *viz.*, I. Tensor Calculus and II. Applications. Part I contains the following articles : Vector Spaces ; Affine Euclidean Point Spaces ; Tensor Algebra ; Curvilinear Co-ordinates in Euclidean Space ; Riemannian Spaces. Part II contains the following articles : Tensor Calculus and Classical Dynamics ; Special

Relativity and Maxwell's Equations and Elements of the Relativistic Theory of Gravitation.

C. V. R.

Energy-Linked Functions of Mitochondria. Edited by Britton Chance. (Academic Press, New York and London), 1963. Pp. xi + 282. Price $ 4.50.

This volume contains a collection of papers presented at the First Colloquium of the Johnson Research Foundation of the University of Pennsylvania, Philadelphia, April 13, 1963.

The interests of the participants in the Colloquium allowed the programme to develop along the three general lines of research which constitute the three main divisions of this volume : the use of mitochondrial energy sources for the formation of reduced substances, particularly DPNH and TPNH ; the transfer of this reducing power from DPNH to TPNH in transhydrogenase reactions, or in substrate reduction such as glutamate synthesis ; and finally, the utilization of such reducing power in ion accumulation or in bacterial photosythesis.

C. V. R.

General Stochastic Processes in the Theory of Queues. By Vaclav E. Benes. (Addison-Wesley Publishing Company, Inc., U.S.A. and London), 1963. Pp. vii + 88. Price $ 5.75.

This book, which treats the topic of delays in queueing systems with one server, offers both a general, rigorous mathematical theory and a useful account of its applications. Because of this balance, the book should be of value to both mathematicians and engineers.

The contents of this volume are as follows : Virtual Delay ; Delay Formulas : A Direct Approach ; Delay Formulas : An Approach Using Transforms ; Weak Stationarity : Preliminary Results ; Weak Stationarity : Convergence Theorems ; Weak Markov Assumptions.

C. V. R.

Beekeeping in India. By Sardar Singh. (Indian Council of Agricultural Research, New Delhi), 1962. Pp. 214. Price Rs. 8·00.

Success in beekeeping is largely a question of proper understanding of the biology and the behaviour of the honeybees and their proper management including knowledge of their diseases and enemies and latest equipment for handling them. An attempt has been made by the author to put into this volume authentic and up-to-date information on all aspects of beekeeping in a concise and popular style. It is intended to serve as a handy reference and guide book for students of agriculture, extension workers and all those who are interested in beekeeping either as a hobby or as a profession.

The chapter headings of the subject-matter contained in this book are as follows : Importance of Beekeeping ; The Honeybee ; Species of Honeybees ; Indigenous Methods ; Equipment ; How to Acquire Bees ; Bee Pasturage ; Seasonal Management ; Miscellaneous Manipulations ; Enemies and Diseases ; Honey and Beeswax ; A Pollinating Agent.

C. V. R.

Elements of Finite Probability. By J. L. Hodges, Jr. and E. L. Lehmann. (Holden-Day, Inc., 728 Montgomery Street, Sanfrancisco), 1965. Pp. 230. Price $ 5.20.

This publication is Part I of the authors' book *Basic Concepts of Probability and Statistics,* and has been made available separately for use as an elementary text-book on probability only to be taught at the precalculus level. The treatment is thus restricted to finite probability models, and is clear and practical. The book can be recommended particularly to instructors who have to introduce the subject to students at beginning level. The book contains over 400 problems, and a key to the problems is available with the publishers for 35 cents.

A. S. G.

Light Scattering from Dilute Polymer Solutions (*International Science Review Series,* Volume 3). Editors : D. McIntyre and F. Gornick. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1965. Pp. 340., Price $ 5.95.

The application of light scattering to the study of the molecular properties of polymeric solutes has proved extremely fruitful, and the technique has become routine in nearly all polymer laboratories. Literature on the subject is scattered in journals and not a few of them have become unavailable as reprints. Thus a collection of original basic papers on light scattering in polymer solutions will form a ready reference and a convenient source-book of primary information on the subject to polymer chemists.

The present publication which forms the third volume in the *International Science Review Series,* contains a selection of thirty-three papers, broadly confined to dilute solutions of flexible macromolecules, and are reproduced as they originally appeared in the journals.

A. S. G.

Optical Rotatory Dispersion and Circular Dichroism in Organic Chemistry. By Pierre Crabbe. (Holden-Day, Inc., 728, Montgomery Street, Sanfrancisco), 1965. Pp. 378. Price $ 12.95.

Many publications have appeared within the last decade on optical rotatory dispersion and its applications to organic chemistry. The latest classical book on the subject was by Carl Djerassi published by McGraw-Hill in 1960. Since then rapid improvements have taken place in instrumentation for optical rotatory dispersion and circular dichroism. The new spectropolarimeters and dichrographs are being increasingly used to solve problems of organic stereochemistry. A descriptive monograph offering the basic principles of these two techniques and their applications would clearly be welcome. The book under review by Pierre Crabbe is specially addressed to research chemists in this field of study. It illustrates with specific examples, selected from latest studies, the wide possibilities of these techniques, and suggests how to handle specific structural and stereochemical problems.

A. S. G.

Marine Microbial Ecology. By E. J. Ferguson Wood. (Chapman and Hall, 11 New Fetter Lane, London E.C. 4), 1965. Pp. 243. Price 42 sh.

This is an outstanding monograph on marine micro-organisms written by one who is devoting his life to marine microbiological research and so can speak with authority on the subject. Professor Ferguson Wood's deep knowledge of the subject is evident in every aspect of the problem discussed and the presentation is unusually clear and precise. Besides giving a succinct integrated account of our present knowledge on this field of research the author has highlighted a number of problems which await solution. There is no doubt that the monograph will stimulate research students in marine microbial ecology to whom the book is specially intended. Extensive bibliographies cited at the end of each chapter will help them to follow up the subject.

The treatment is under the following chapter headings : Introduction ; The Marine Environment ; The Micro-organisms ; Aspects of Productivity ; Microbial Processes ; The Effects of Physical and Chemical Factors on Micro-organisms ; Pathological Micro-organisms in

Hydrobiology ; Ecosystems of the Marine World ; Methods in Marine Microbiology.

The book includes two sets of seven plates each, the first set illustrating various types of Diatoms and Dinoflagellates, and the second set illustrating methods and equipment for collecting oceanographic samples.

A. S. G.

Books Received

Basic Concepts of Nuclear Chemistry. By R. T. Overman. (Chapman & Hall, London E.C. 4), 1965. Pp. xi + 116. Price 10 sh. 6d.

Human Chromosome Methodology. Edited by J. J. Yunis. (Academic Press, New York-10003), 1965. Pp. xiv + 258. Price $ 8.50.

The Atomic Nucleus. By M. Korsunsky. (Gordon and Breach, New York-11), 1965. Pp. 453. Price $ 12.50.

Irreducible Representations of the Space Groups. By O. V. Kovalev. (Gordon & Breach, New York-11), 1965. Pp. 154. Price $ 7.00.

The Science Dictionary in Basic English. By E. C. Graham. (Evans Brothers Ltd,. Montague House, Russell Square, London W.C. 1), Pp. xvi + 568. Price 30 sh.

Chemical Technology, Vol. 2—Industrial Wastewater Control. By C. F. Gurnham. (Academic Press, Inc., 111, Fifth Avenue, New York-11), 1965. Pp. x + 476. Price $ 16.00.

The Indian Year Book of Education (Part 1)— *A Review of Education in India* (1947-61). Revised Edition. (The National Council of Education Research and Training, New Delhi), 1965. Pp. xxii + 420. Price Rs. 17·00.

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Borides, Silicides and Phosphides. By B. Aronsson, T. Lundstrom and S. Rundquist. (Methuen & Co., Ltd., New York), 1965. Pp. x + 120. Price 25 sh.

Physical Acoustics Principles and Methods. and Solutions. Edited by W. P. Mason. 476. Price $ 17.00.

Introduction to Modern Biochemistry (Second Edition). By P. Karlson. (Academic Press, New York), 1965. Pp. xx + 436. Price $ 11.00.

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SIR C. V. RAMAN

WE live in a colourful world and we are educated by our environment to love and admire colour. The blue sky, the red glows of sunrise and sunset, the green colour of vegetation and the varied hues of flowers are always with us as a reminder of our ability to perceive colour and to distinguish even subtle differences in colour. Inevitably, therefore, man has sought to emulate Nature and to surround himself with various products of his own handiwork which display colours rivalling those of Nature. We need only mention a few examples. The dyeing of textiles and the production of ceramic wares are fields in which human ingenuity has sought to produce works of art which derive their inspiration from the products of Nature but differ from many of them in exhibiting the quality of permanency.

A further consequence of the love of colour is the desire to record the fleeting scenes of colour with which Nature provides us in a more enduring form. The art of painting in colour had its origin in this desire, but has developed into one of the highest forms of expression of the human spirit comparable in its value and appeal to any others which could be mentioned. But this way of reproducing colour has its limitations. It is laborious and time-consuming, and the excellence of the final product is a highly variable and uncertain quantity. Further, when a picture has been painted which has an enduring value, those who wish to see it have to travel—if necessary to the other end of the earth—to the place where it has found a resting place.

The foregoing is an attempt to explain the reasons why the reproduction of colour by quasi-mechanical processes has, at the present time, assumed an importance comparable with that of the closely allied art of printing. The development of the processes by which colour is reproduced has been essentially on an empirical basis in which trial and error have played the major role. Nevertheless, useful guidance has been forthcoming from experience gathered in other fields of activity in the production of colour, viz., painting and dyeing. To some extent also, it has benefited by the reported results of the studies on colour mixing made by physicists and others in the nineteenth century.

We shall here approach the subject of colour-reproduction from the new points of view indicated by the studies on colour described in our preceding chapters. We shall choose a specific case of a physical phenomenon in which we observe colour and which has the merit that it can be called into existence exhibiting identical characters whenever desired. We then set ourself to the problem of how a picture of it can be made of it which can claim some measure of resemblance to the original.

The phenomenon which is here referred to is that of the colours of interference, the best-known example being that of Newton's rings as seen in white light under sufficient magnification. A detailed description of these rings has been given in an earlier chapter in which the highly important role played by the yellow sector of the spectrum in the effects observed has been clearly set out. The major feature of these rings is the fluctuation of luminosity which exhibits itself as a regular succession of maxima and minima of illumination. The positions of these maxima and minima are determined by the wavelength of yellow light and this is shown by actual measurement of the positions of the minima of illumination to be $579 \, m\mu$. The minima of illumination are highly pronounced: in particular the first minimum is almost perfectly black, and the second minimum is also very dark.

If now it is proposed to produce a picture of the rings as we see them on a piece of white card with a small brush and using coloured inks of different sorts, it is evident that a minimum of four inks of different colours would be needed: black ink, yellow ink, red ink and green ink. The black ink would be needed for exhibiting the central black area in the ring system, and the first two or three of the minima of illumination which cannot otherwise be represented. The yellow ink would be needed to exhibit the colour of the brightest part of the first three rings in the pattern. The red and the green inks would be needed to represent the colours in the regions respectively preceding and following the circles of minimum illumination in the first few rings. They would also be needed to represent the alternations of colour perceived in the outer rings of the pattern.

It is obviously not an accidental circumstance that in the processes of colour printing, it is also customary to use four colours, *viz.*, yellow, magenta, cyan and black in the order stated. Usually, the first printing is with the yellow ink, the second printing is with the magenta ink, the third printing is with the cyan ink, while the fourth printing is with black ink. The last printing completes the picture which would otherwise fail to exhibit the local contrasts in respect of brightness exhibited by the object itself.

may be described as exhibiting a colour which is predominantly red. But spectroscopic examination reveals that while the green and yellow sectors are both much weakened, the red sector is accompanied by the blue sector with quite appreciable intensity. Likewise, the cyan ink shows both the green and the blue sectors in great strength while the yellow and red sectors are both much weakened. A white surface which has been printed upon with yellow ink when examined spectroscopically shows that the observed colour is the result of
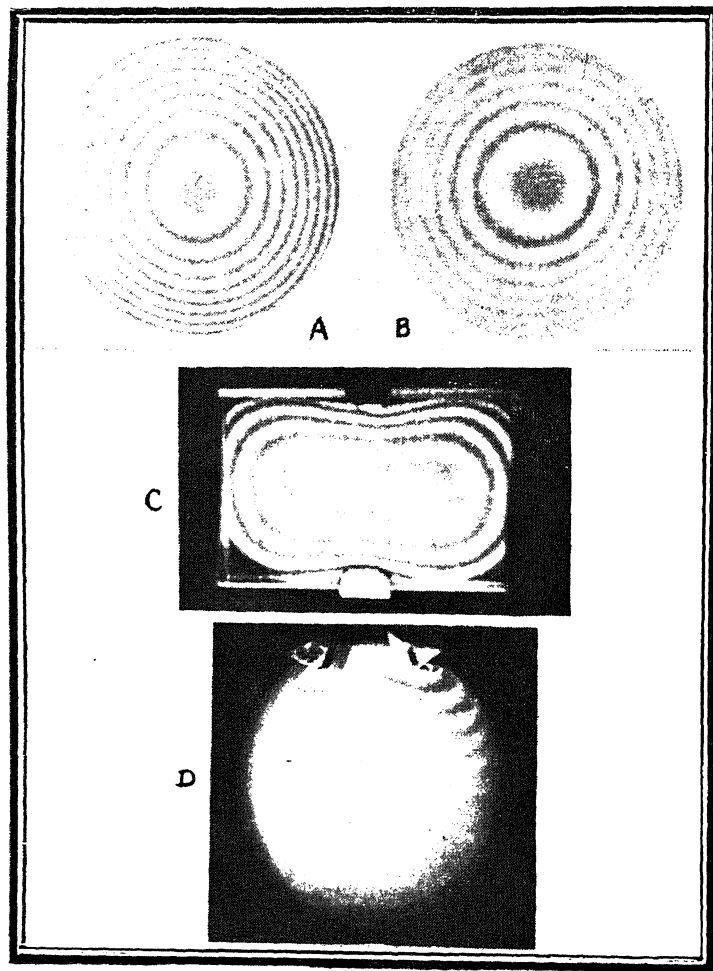

FIG. 1. A–B—Newton's Rings; C—Interference figures of convex air film; D—Interference figures of wedge-shaped air film. All photographs were recorded with white light and panchromatic films except A which was taken with sodium light.

Some remarks may be made here regarding the three coloured inks used in process-colour printing. White printed on with magenta ink

the nearly complete extinction of the blue sector, while the green, yellow and red sectors are all present in practically undiminished strength.

It is necessary to indicate how the four blocks used respectively for the four printings are prepared. The negative for the yellow printer is made by using a blue filter when photographing the object. Likewise, for the magenta printer, a green filter is used, and for the cyan printer, a red filter. For the black printer several alternative procedures are available, the simplest being the use of a yellow filter. The choice of the filter used in making the three colour-separation negatives is based on the idea that the colour which is transferred to the paper by the printer should be complementary to that transmitted by the filter used in making the negative.

It should also be mentioned that the printing blocks are prepared by the half-tone process. The cross-line screen used in the process results in the breaking up of the picture into thousands of dots of light of varying size. These dots would appear in the impressions recorded on the paper by each of the four printing blocks. It should be emphasised that it is not the intention that the sets of dots in the impressions left by the four blocks should be coincident. On the other hand, to avoid such coincidences as far as possible, the half-tone screens are set at different angles to each other, these being so chosen as to avoid the appearance of moiree patterns or other objectionable features in the reproductions. To secure these results, it is sometimes found desirable to use a different screen-ruling for the yellow plate than for the plates of other colours.

If, in the picture as finally printed, the dots of different colours do not actually overlap, the eye is presented with a mosaic in which areas of white, black, yellow, magenta and cyan of varying sizes are interspersed. It would evidently be not possible for the eye to take note of their individual presence and the visual impression would therefore be a synthesis in which the effects of the individual areas are integrated into a single sensation. This sensation would depend on the relative proportions of the five areas exhibiting different colours. As the absorption spectra of the three coloured inks are very different, we may expect that a wide range of colours would be exhibited in various cases.

When photographic reproductions in colour are viewed through a magnifier, the structures which appear in them as areas of colour are immediately recognisable. In some cases, they exhibit hexagonal outlines, in others they appear as squares. The sizes of the individual dots and the colours which they show can readily be related to the colour exhibited to the eye by the entire group. Where the colour is yellow or blue-green or magenta, the dots of those colours are naturally predominant. In areas exhibiting other colours, the presence of dots of two or three different colours is evident and their influence on the perceived colour is readily traceable.

Summing up, we may say that when we view a photographic reproduction in colour, in general we perceive hues which are not really there, but represent a synthesis effected within the eye of the observer. The actual processes employed and especially the need for a fourth block which prints in black and white is a clear disproof of the idea that the reproduction of colour is based on the trichromatic hypothesis of colour perception.

MACH BANDS *

THIS is the first book devoted to a detailed consideration of the Mach bands, a visual phenomena discovered in 1865 by Ernst Mach. It surveys theoretical formulations advanced to explain the Mach bands, relating theory to actual experiments on the retina.

Explanations are given in terms of the inhibitory interaction among neural elements in the retina, and consideration is given to the role of inhibition as a "sharpening mechanism" and as a possible basis for mechanisms for the detection of complex patterns and movement. A biographical sketch of Mach and an account of the relevant features of his theory of knowledge are presented.

The author in this volume brings together and integrates the contribution made to a specialized field by psychology, neurophysiology, psychological optics, mathematics, the theory of knowledge, and the history of science. It is directed to the advanced student in psychology, physiology, and related fields, and to the researcher in industries concerned with the transmission of information and pattern recognition.

X-RAY ANALYSIS OF THE CRYSTAL STRUCTURE OF L-VALINE HYDROCHLORIDE MONOHYDRATE *

S. THYAGARAJA RAO

Centre of Advanced Study in Physics, University of Madras, Madras-25, India
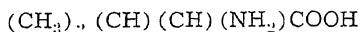
AND

R. PARTHASARATHY

Department of Biophysics, Roswell Park Memorial Institute, Buffalo-3, N.Y., U.S.A.

1. INTRODUCTION

THE investigation of the crystal structure of the amino-acid L-valine

$$(CH_3)_2 (CH)(CH)(NH_2)COOH$$

in the form of its hydrohalides was undertaken in this laboratory as a part of a major programme of work on the compounds related to proteins. The crystal structure of the isomorphous pair—L-valine hydrobromide and L-valine hydrochloride—which belong to the space-group $P2_1$ with a bi-molecular unit-cell have already been determined in this laboratory (Parthasarathy, 1962 ; Parthasarathy and Chandrasekharan, 1965 ; Parthasarathy and Ramachandran, 1965). The hydrochloride alone crystallised in another completely different form and was found to occur along with the other form during crystallisation. This form is a monohydrate while the other, isomorphous with the hydrobromide, had no water of crystallisation. The structure of the monohydrate of L-valine hydrochloride has now been completely established and this is a brief preliminary account of this investigation, the details of which will be published in due course.

The crystallographic data of L-valine hydrochloride monohydrate are :

Space-group : $P2_12_12_1$
Cell contents : $4(C_5NO_2H_{11}.HCl.H_2O)$
Cell dimensions : $a = 6\cdot84$; $b = 21\cdot22$; $c = 6\cdot17$ Å
Observed density : $1\cdot26$ gm./c.c.
Calculated density : $1\cdot27$ gm./c.c.

2. STRUCTURE DETERMINATION

Three-dimensional intensity data were collected for layers L = 0 to 4 along the c-axis. As the crystals were small and hygroscopic, the crystal could not be cut and mounted about a-axis for data collection. However, precession photographs of the $(h\,0\,l)$ and $(0\,k\,l)$ reflec-

tions were taken and used for correlation of data initially. The intensities were estimated visually and corrected for Lorentz and polarisation factors and were placed on an absolute scale using layerwise Wilson plots and also the intensities from the precession films. No absorption corrections were made as the crystal used was very thin.

Initially attempts were made to determine the structure in the c-axis projection. This failed to reveal the structure and complete three-dimensional work was undertaken. A sharpened three-dimensional Patterson diagram gave the chlorine co-ordinates and using the phases from this atom, α-synthesis and a γ'-synthesis (Ramachandran and Raman, 1959 ; Raman, 1959) were computed. The α-synthesis has coefficients

$$\alpha = |F_0|^2 |F_p| \exp.\ (i\,\alpha_p)$$

where $|F_p|$, α_p are the amplitude and phase of the chlorine atoms and $|F_0|^2$ the observed intensity. A comparative study of these maps revealed most of the atoms of the molecule and the water molecule. The two carbon atoms of the terminal methyl groups which did not come up well in these maps were fixed from a calculation of the two projection maps down the a and c axes used in phasing all the other atoms.

A series of least-squares cycles with individual isotropic temperature factors reduced the R-value for the observed reflections from $0\cdot35$ to $0\cdot142$. A layerwise scaling followed by three more cycles reduced the R-value to $0\cdot129$. A further three cycles, allowing anisotropic thermal parameters for all the atoms to vary, reduced the R-value to $0\cdot110$. The positional parameters of all non-hydrogen atoms at this stage are given in Table I. The numbering of various atoms is shown in Fig. 1 which also gives a picture of the packing of the molecules viewed down the c and a axes.

The bond lengths and bond angles are quite satisfactory. There are no unusually short contacts in the structure. The structure is

TABLE I

Atom	x/a	y/b	z/c
Cl	0·3220	0·0953	0·1281
O_1	0·9048	0·0556	0·4683
O_2	0·0983	0·1402	0·5194
O_3 (W)	0·4841	0·0129	0·5109
N	0·7177	0·0710	0·8464
C_1	0·9556	0·1035	0·5791
C_2	0·8632	0·1208	0·7889
C_3	0·7756	0·1873	0·7734
C_4	0·6016	0·1888	0·6278
C_5	0·7223	0·2121	0·0080

A detailed discussion of the stereochemistry and a comparison with the monoclinic form will be presented elsewhere.
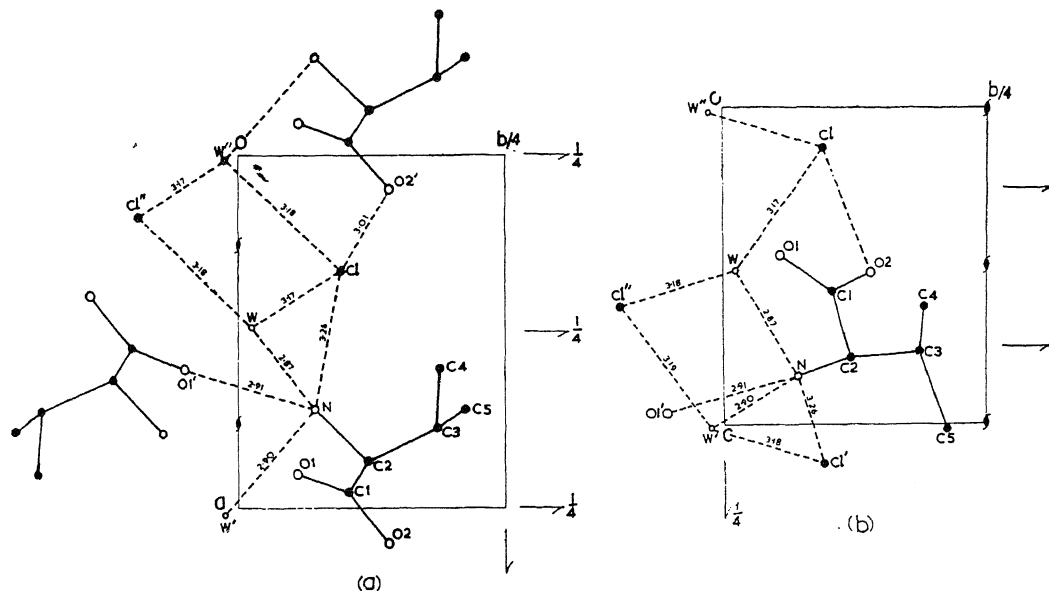
FIG. 1. Packing diagram of the structure. (*a*) View down the *c*-axis; (*b*) View down the *a*-axis.

stabilised by a set of hydrogen bonds, running primarily parallel to the *a*-axis. The amino group $(NH_3)^+$ takes part in hydrogen bonding with four neighbouring atoms: $N^+H \ldots Cl^- = 3 \cdot 26$ Å; $N^+H \ldots O(W) = 2 \cdot 87$ Å; $N^+H \ldots O(W')$ $= 2 \cdot 90$ Å; and $N^+H \ldots O_1' = 2 \cdot 91$ A forming a bifurcated bond with the last two acceptor atoms. The (OH) of the carboxyl group takes part in a strong hydrogen bond with chlorine with $O-H \ldots Cl^- = 3 \cdot 01$ Å. The two protons of the water molecule bond with two chlorines: $OH \ldots Cl^- = 3 \cdot 17$ and $OH \ldots Cl^- = 3 \cdot 18$ Å.

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FIRST RECORD OF *TROPIDOCEPHALA SACCHARIVORELLA* MATS. FROM INDIA

V. P. RAO

Commonwealth Institute of Biological Control, Indian Station, Bangalore, India

DAMMERMAN (1929) mentions the Delphacid, *Tropidocephala sacchearivorella* Mats., as a rather serious pest of sugarcane in South China and Formosa and that it has also been recorded from Mindanao, in the Philippines. Copeland (1917) and Schumacher (1920) earlier referred to its occurrence on sugarcane in the Philippines and Formosa respectively, the former considering it to be of pest status. Box (1953) recorded it as occurring only in China (Southern), Formosa and the Philippines (Mindanao). However, Johnston (1961) mentioned its occurrence on sugarcane only in the Philippines.

During the course of work on sugarcane pests and their natural enemies, the present author has recorded this species for the first time on sugarcane at Bangalore and Mandya in Mysore State, India. According to information received from the Commonwealth Institute of Entomology, London, to whom material was sent for identification, this is the first record from India. Additional material of the same species had also recently been received from Kantalai, Ceylon. Usman, Sivashankara Sastry and Puttarudriah (1957) have listed a *Tropidocephala* sp., under "casual insects (incidental insects)" collected on sugarcane in the Visvesvaraya Canal tract of Mandya District. It is quite possible that the species referred to by them is the same as the one now under consideration. Although it may, at present, be an unimportant insect in India, in view of the fact that it is said to be a serious pest of sugarcane in South China and Formosa (Taiwan), it would appear to be worth-while making a careful survey of all the sugarcane growing areas in India to (1) find out its exact present distribution and (2) keep a watch on it so that immediate and effective measures for its control can be undertaken should its population increase in any area, possibly as a result of any changes that might occur in methods of sugarcane cultivation, irrigation, etc.

To enable those connected with sugarcane cultivation in the country to recognize the pest, an illustration of it is included in this note. It is a pale greenish insect 3 to 4 mm. in length, the forewings being hyaline with brown lines and spots, the apical portion with four longitudinal blackish stripes.

Although one may surmise that certain ecological conditions have not permitted this insect to attain a pest status so far in India, a case for comparison is that of *Numicia viridis* Muir which was unknown as a pest of sugarcane in South Africa until 1962 when symptoms of its attack became acute over a considerable part of the sugarcane plantations in Swaziland and parts of Natal and today it is one of the most destructive of pests of sugarcane in that country.
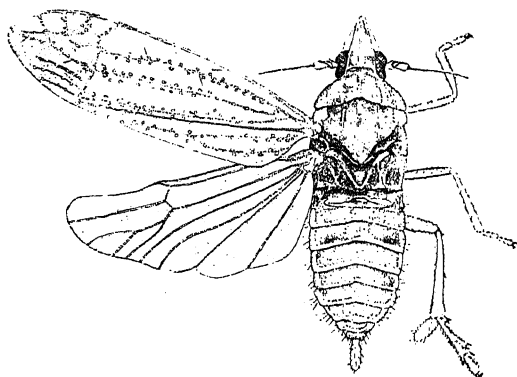

FIG. 1. Dorsal view of *Tropidocephala saccharivorella* Mats., × 35.

It is quite possible that the native home of *T. saccharivorella* is South China and it has gradually spread to Taiwan, the Philippines and Indonesia. There is also a possibility that the insect has been introduced into India along with Java varieties of sugarcane in earlier years when plant quarantine stations did not exist at ports of entry. The record of this possibly exotic insect again stresses the importance of plant quarantines to prevent the spread of insect pests from one country into another.

Although *T. saccharivorella* is an important pest, no information is available as regards its natural enemies in South China, Taiwan, the Philippines or Indonesia. Box (1953) does not mention any of them. It may, therefore, be worthwhile for all countries where the insect occurs to make a survey and find out what its natural enemies are and arrange for their exchange, if any of them do not occur in a country with a view to trying the same for biological control of the pest.

The author is very grateful to Mr. E. O. Pearson, Director, Commonwealth Institute of Entomology, for arranging to identify specimens of this species collected by him.

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MIXING AND CIRCULATION IN GAUTAMI-GODAVARI ESTUARY

P. N. GANAPATI AND D. V. RAMA SARMA

Department of Zoology, Andhra University, Waltair

THE nature of circulation in the river estuaries has been discussed in considerable detail by Rochford,[9] Redfield,[7] Ketchum,[3,4] Pritchard,[5,6] and Stommel.[10] The circulation in Fjord type of estuaries has been discussed by Tully,[13] Redfield[8] and Cameron.[1] An extensive review of the nature of circulation in different estuaries has been made by Stommel and Farmer.[11] The need for a critical study of Indian estuaries was pointed out by Seshaiya.[12] Jacob and Rangarajan[2] observed that in mixing and circulation the Vellar estuary resembles the atidal south-west Australian estuaries in general and the Swan river system in particular.

The distribution of salinity in relation to the depth and distance has been studied during the years 1958-62 in the Gautami branch of the Godavari estuary, the second largest in the country.

With the onset of the south-west monsoon heavy drainage of freshwater into the estuarine limits of the river occurs commencing from early July so that a freshwater isostatic head develops rather abruptly. This naturally results in a gravity-impelled flow of water in the direction of the confluence from the head, effecting to begin with, a rapid seaward displacement of the surface waters. With the seaward flow of fresh or brackish water at the surface level and high saline water moving in along the bottom, a steep halocline ensues. Because of the suppression of the tidal pressure from the sea, the halocline formed effectively prevents vertical mixing. When the inflows gain greater momentum resulting in high floods, a total disruption of the prevailing salinity structure takes place culminating in a complete freshwater scouring of the whole system. During this prolonged period of high floods, the river waters reach the sea unimpeded and the incoming tides are completely blocked. This state of complete freshwater scouring of the estuary continues from about the end of July upto September (Fig. 1, 4). This is due to (1) heavy freshwater drainage in the form of a series of intermittent spates when the seawater intruding along the bottom from the confluence gets pushed back and (2) the shape of the estuary with a narrow mouth compared to the great width higher up.

The recovery cycle leading to the establishment of estuarine conditions is rather slow compared to the rapidity with which the entire system has been disrupted and freshwater scouring occurred. Consequent on the diminution of freshwater inflow beginning usually from October, neritic penetration gains prominence as evidenced by the establishment of brackish water conditions in the fore-estuary because of the gradual fall in the level of the freshwater isostatic head and a simultaneous progressive manifestation of the marine isostatic head. During this recovery phase the establishment of vertical salinity gradient occurs first at the confluence (Fig. 1, 3). A progressive shift in the establishment of the zone of vertical salinity

gradient takes place in the direction of the head of the estuary owing to the increased neritic penetration assisted indirectly by the decreased freshwater inflows from the head. During this fairly prolonged post-flood period when vertical salinity gradient prevails (Fig. 1, 2), the mixing boundaries to begin
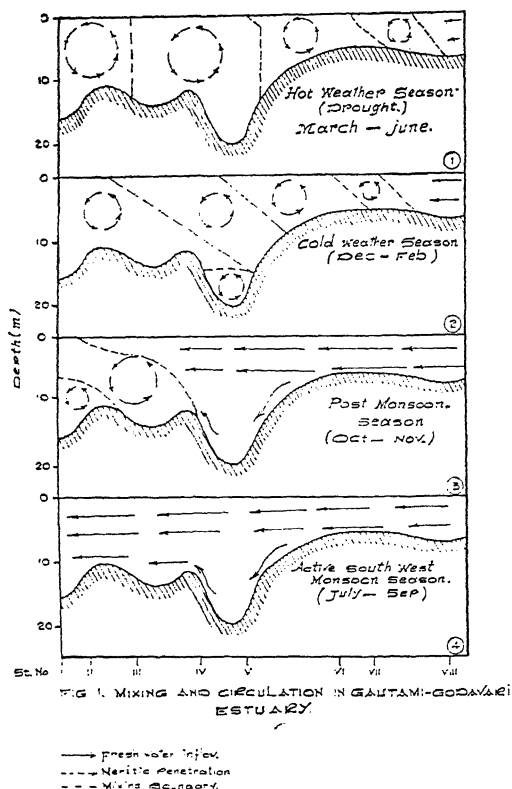

FIG 1. MIXING AND CIRCULATION IN GAUTAMI-GODAVARI ESTUARY.

→ Fresh water inflow
---→ Neritic Penetration
- - - Mixing Boundary.

with are oriented horizontally in the fore-estuary. As the neritic penetration increases the horizontal mixing boundaries become shifted in the upriver direction. This is indicated by the formation of a halocline at different regions in the estuary. In the upper reaches, however, the mixing boundaries vary from a horizontal to a diagonal position during the period of moderate runoff and become semi-vertical during the hot weather season. The marine domination prevails during the period March to early June in the lower estuary because of the prevailing drought conditions. During the above period no surface-bottom differences in salinity prevail owing to intense

vertical mixing brought about by the tides actively assisted by the prevailing local winds (Fig. 1, 4). In the upper reaches, however, vertical differences in salinity do exist but they gradually become reduced from higher values in the post-flood period to very low values in the drought period.

The absence of vertical differences in salinity in the lower estuary during the hot weather season suggests operation of a "cellular type" of circulation as observed by Rochford[9] in the typical tidal eastern Australian systems. The vertical homogeneity in the dissolved oxygen and nutrient concentrations also lend support to the possible occurrence of a "cellular type" of circulation. Under the influence of the tides these bodies of water move back and forth, each about a mean position. During the early phase of the annual flood period a rapid seaward displacement of these 'cells' of water occurs. When the river runs into high spates the pattern of cellular circulation becomes disrupted and the estuary becomes filled with freshwater at all levels.

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LETTERS TO THE EDITOR

THERMAL EXPANSION OF AMMONIUM DIHYDROGEN ARSENATE, NH₄H₂AsO₄

AMMONIUM dihydrogen phosphate (ADP) and potassium dihydrogen phosphate (KDP) are two isomorphous crystals belonging to the space-group I $\bar{4}2\,d$. However, there is some difference in their structures. The potassium salt has only one system of hydrogen bonds connecting the oxygen atoms of the neighbouring PO_4 groups. The ammonium salt, on the other hand, has two types of hydrogen bonds, one of these being similar to the O—H...O bonds present in KDP and the other a system of N—H...O bonds linking each cation with four neighbouring anions.[1] These structural features are reflected in certain differences in the physical properties of these two crystals,[2] the most striking being the difference in the relative magnitudes of the principal coefficients of their thermal expansion. The arsenic acid salts of these two cations, namely ammonium dihydrogen arsenate (ADA) and potassium dihydrogen arsenate (KDA), are also known to be isomorphous with the phosphates. It may, therefore, be expected that the two arsenates will also show a difference in the anisotropies of their thermal expansion. An X-ray study of the thermal expansion of KDA has recently been reported by the authors.[3] As no report is available on the determination of the lattice parameters at different temperatures or the thermal expansion of ADA, this investigation was undertaken.

Crystals of ADA were prepared by evaporating a heated mixture of the aqueous solutions of As_2O_5 and ammonia. A high temperature single crystal camera and $CuK_{\alpha\beta}$ radiation were used in obtaining back-reflection rotation pictures at different temperatures. Conventional analytical methods of eliminating systematic errors were employed in the calculations of the lattice parameters. Figure 1 shows the values of the cell constants at different temperatures along with the limits of experimental errors. Analysis of these temperature-parameter data gives the following expressions for the temperature variation of the two parameters.

$$a_t = 7 \cdot 6996 + 14 \cdot 34 \times 10^{-5}\ (t - 20) + 21 \cdot 18 \times 10^{-8}\ (t - 20)^2$$

$$c_t = 7 \cdot 7158 + 7 \cdot 41 \times 10^{-6}\ (t - 20).$$
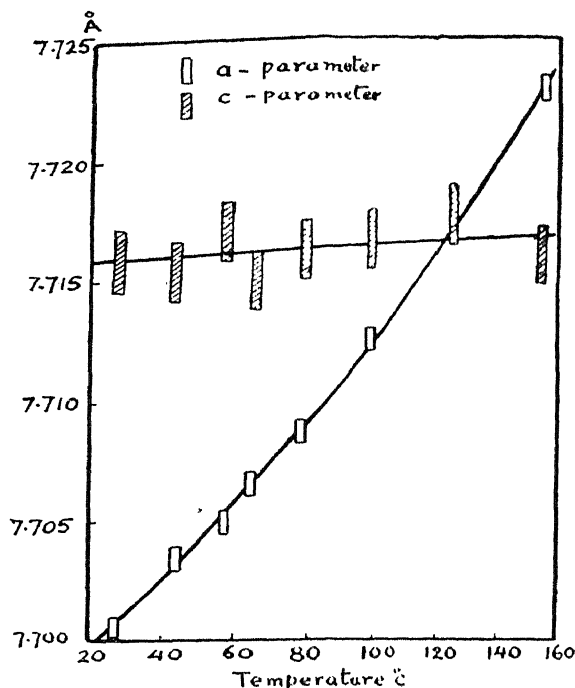
FIG. 1

Here a_t and c_t are the values of the parameters in Å at $t°$ C. The two principal coefficients of thermal expansion, derived from these, come out as

$$a_a = 18 \cdot 62 \times 10^{-6} + 55 \cdot 02 \times 10^{-9}\ (t - 20)\ \text{deg. C}^{-1}$$

$$a_c = 0 \cdot 96 \times 10^{-6}\ \text{deg. C}^{-1}.$$

The mean coefficient of expansion of the a-parameter between 20° and 155° C. is $22 \cdot 3 \times 10^{-6}$ deg. C⁻¹.

The values of the lattice parameters at 20° C. obtained from the present data are in satisfactory agreement with the values reported by Delain.[4]

Table I gives a comparison of the values of

TABLE I

		c/a	$a_a \times 10^6$	$a_c \times 10^6$	Reference
KDP	..	0·934	26·9	46·6	5
KDA	..	0·937	24·9	50·0	3
ADP	..	1·008	39·3	1·9	2
ADA	..	1·002	22·3	1·0	Present work

the axial ratio and mean coefficients of expansion of ADA with those of KDP, KDA and ADP.

It can be seen from Table I that the c-parameter thermal expansion of the two ammonium salts is much smaller than the a-parameter expansion. This is in a clear contrast with the behaviour of the two potassium salts, the value of α_c for both of them being greater than α_a. A possible explanation of this interesting difference between the phosphates of the two cations, as suggested by the authors,[2] is the role of NH_4 ions present in ADP. The same explanation will hold good even for the arsenates. An interesting feature of the thermal expansion of ADA is that at 122° C. its axial ratio becomes equal to unity and at higher temperatures it is less than one.

Note.—At the time of writing this note the authors have come across a recent paper in which, besides the elastic constants and thermo-elastic data, values of lattice constant at room temperature and principal coefficients of thermal expansion of these crystals have been reported.[6] These values are found to be in satisfactory agreement with the data being presented by the authors.

One of the authors (A. A. K.) desires to express his gratitude to the C.S.I.R. for the grant of a Research Fellowship.

Physics Department,   V. T. Deshpande.
Univ. College of Science.   A. A. Khan.
Osmania University,
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C-GLYCOSIDES OF *PARKINSONIA ACULEATA*

Parkinsonia aculeata, a glabrous bush or low tree, is grown as a hedge plant all over India. It is known to give beautiful yellow flowers. In an earlier publication[1] we reported the isolation of epi-orientin (I), parkinsonin-A (5-O-methyl orientin, II) and parkinsonin-B (5, 7-di-O-methyl epi-orientin, III) from the leaves of *P. aculeata.* We have recently had occasion to examine the flowers of this plant in order to see if they also produce C-glycosides. As a result it is found that the flowers are a better source and a simpler extraction procedure affords a higher yield of the glycosides. However, the components are the same, epi-orientin being the major and parkinsonin-A and parkinsonin-B being somewhat less.
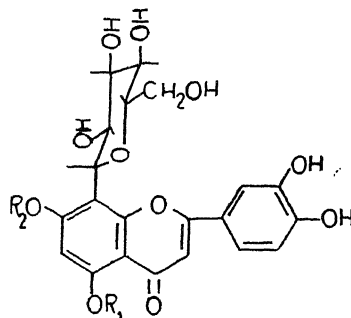
    I R_1 , $R_2 = H$
    II $R_1 = CH_3$, $R_2 = H$
    III R_1 , $R_2 = CH_3$

Fresh flowers (150 g.) were extracted with hot ethanol (5 × 1 l.; 4 hr. each time). The solvent was removed from the combined extracts under reduced pressure and the aqueous solution diluted with water (100 ml.). It was then extracted with ethyl acetate (500 ml.; 7 × 24 hr.) changing the solvent after every 24 hr. Concentration of the combined ethyl acetate extracts to a small volume gave the mixture of pigments (8 g.). The yield of the individual pigments obtained after separation using preparative paper chromatography was: epi-orientin (0·60%, on air-dry basis), parkinsonin-A (0·38%) and parkinsonin-B (0·25%).

Department of Chemistry,   V. K. Bhatia.
University of Delhi,   S. R. Gupta.
Delhi-7, *July* 5, 1965.   T. R. Seshadri.

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OCCURRENCE OF LEUCOPELARGONIDIN IN THE ROOTS OF *CASEARIA ESCULENTA* ROXB.

Casearia esculenta root is a well-known Ayurvedic drug. In the course of a chemical study we found that it is relatively rich in leucoanthocyanidin. The isolation of this leucoanthocyanidin and its characterisation as leucopelargonidin are described hereunder.

The isolation was made from a cold acetone extract of the drug which had been previously

extracted with petroleum ether and ether. The acetone extract was concentrated under reduced pressure and diluted with water. The precipitated coloured solid was filtered off and the clear filtrate repeatedly extracted with ethyl acetate. The combined ethyl acetate solution was dried over anhydrous magnesium sulphate, concentrated under reduced pressure and diluted with a large volume of dry petroleum ether. The almost colourless powder that separated was purified by taking up in ethyl acetate and precipitation with excess of petroleum ether and repeating the process twice.

The colourless solid,* m.p. 220° (decomp.), $[\alpha]_D^{26} = +8\cdot8°$ (absolute ethanol) was easily soluble in water and alcohol and insoluble in benzene and chloroform. On heating with aqueous hydrochloric acid, a red colour developed and a coloured insoluble precipitate was slowly formed (phlobaphene). An alcoholic solution gave a green ferric colour.

The flavylium salt which was obtained by refluxing with 10% alcoholic hydrochloric acid for 4 hr., filtering off the insoluble phlobaphene and extracting the filtrate with isoamyl alcohol was obtained in aqueous acid solution by shaking the amyl alcohol solution with 1% hydrochloric acid and a large volume of petroleum ether. The intense red-coloured aqueous acid extract showed an absorption maximum at 530 mμ which did not undergo any shift on the addition of aluminium chloride, and it further showed all the reactions characteristic of pelargonidin chloride. In a paper chromatogram its R_f value was 0·34 using phenol-water (upper phase) as the irrigant.

The parent leuco compound gave a pentaacetate with pyridine and acetic anhydride (room temperature, 48 hr.), m.p. 162–63°, $[\alpha]_D^{26} = +3\cdot7°$ (chloroform). With diazomethane it gave a trimethyl ether, m.p. 192–93°, $[\alpha]_D^{26} = +29\cdot1°$ (absolute ethanol) and this trimethyl ether gave a diacetate with pyridine and acetic anhydride (room temperature, 48 hr.), m.p. 178–80°, $[\alpha]_D^{26} = +18\cdot5°$ (chloroform). Oxidation of the trimethyl ether with potassium permanganate in acetone medium and examination of the acidic part of the reaction product led to the isolation of anisic acid, identified by paper chromatography and by m.p. and mixed m.p. (178–81°). In another experiment the trimethyl ether in aldehyde-free alcohol was oxidized with sodium periodate at room temperature for 24 hr. The reaction product was separated into sodium hydroxide-soluble and -insoluble parts. The latter gave a 2, 4-dinitro-phenyl hydrazone, m.p. 249–52°, underssed by admixture with authentic anisaldehyde 2, 4-dinitrophenylhydrazone.

The above reactions definitely proved the identity of the parent leucoanthocyanidin as leucopelargonidin. Since its optical rotation does not tally with the values recorded in the literature[1,2] for this substance, it is evidently a hitherto undescribed form of the compound which theoretically can exist in 8 optically active forms.

We thank Prof. T. R. Seshadri for his interest and the I.C.M.R. for research grants for the conduct of this study.

Department of Chemistry,   V. KRISHNAN.
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EFFECT OF MERCAPTOPURINE AND URETHANE ON ALKALINE PHOSPHATASE ACTIVITY OF RAT TISSUES

MERCAPTOPURINE and urethane are used in the treatment of leukemia but their exact mechanism of action is not known. The former has been reported to interfere with the synthesis of nucleic acid in neoplastic tissues at the level of purines and hypoxanthine, while the latter, in large doses, produces bone marrow depression and inhibits cell division (Paterson et al., 1946). Pileri et al. (1956) observed an increase in alkaline phosphatase activity in the regenerating liver of rat after mercaptopurine.

As phosphatase enzymes play an important role in the synthesis of nucleic acid, the effects of the above two drugs have been studied on the alkaline phosphatase activity in rat tissues.

MATERIAL AND METHODS

Thirty young albino rats, weighing 100–120 gm., were divided into 3 groups—(*i*) Control rats, (*ii*) Rats treated with mercaptopurine, 0·5 mg. orally daily for a period of 3½ months, (*iii*) Rats treated with urethane, 8 mg. daily for the above period.

On completion of the treatment, the animals were sacrificed and liver, small intestine, tibia, femur, iliac bones and scapula were removed and homogenates (1 : 40) prepared in distilled water using ice-cooled waring blender. Alkaline

TABLE I

Effect of mercaptopurine and urethane on alkaline phosphatase activity in rat tissues

(The figures expressed in terms of mg. of phosphorus liberated)

		Control mg.	Mercaptopurine-treated rats mg.	% response S.D. ±	Urethane-treated rats mg.	% response S.D. ±
Long bones	..	0·2557	0·4183	+63·5 ± 7·2	0·2628	+2·8 ±0·5
Flat bones	..	0·2175	0·3237	+48·8 ± 7·0	0·2174	−0·04 ±0·01
Liver	..	0·0113	0·0142	+25·6 ± 4·6	0·0102	−9·7 ±1·1
Intestine	..	0·6384	0·6698	+ 4·9 ± 1·1	0·4974	−22·0 ±3·1

phosphatase activity was determined by the technique of Bodanski (1933) and the liberated phosphorus was estimated by the method of Fiske and Subba Row (1925). The results are shown in Table I.

It is evident that mercaptopurine stimulated the enzymatic activity in all the four tissues, maximum being in bones. Urethane produced little effect, except in intestine, where the enzymes were inhibited.

Dept. of Pharmacology,   B. C. Bose.
M.G.M. Medical College,   R. Vijayvargiya.
Indore, *May* 14, 1965.   S. Bose.

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FREE AMINO-ACIDS IN COCONUT PALMS AFFECTED BY ROOT (WILT) DISEASE

THE synthesis of virus proteins by plant tissues involves changes in their free amino-acid pool, although such changes may be small and transitory.[1] The probable association of a virus with the root (wilt) disease of the coconut palms had been indicated by Nagaraj and Menon.[2] A comparative study on the amino-acids in coconut palms in health and disease was therefore taken up. The results are reported in this note.

Five gram samples of fresh tender leaves collected from a healthy palm and palms in different stages of disease were extracted with 75% alcohol and shaken with 3 volumes of chloroform. Upper layers were taken, evaporated to dryness and dissolved in 2 c.c.

of water. Aliquots were chromatographed on Whatman No. 3 filter-paper, buffered with KCl-HCl buffer using phenol pH 1, for the first run and butanol : acetic acid : water (4 : 1 : 1) for the second direction.[3] The amino-acids were detected by spraying with a 0·2% solution of ninhydrin in acetone. The identification of amino-acids was confirmed by running chromatograms after addition of known amounts of amino-acids into the extracts.

TABLE I

Free amino-acids in tender leaves of healthy and diseased palms

Amino-acids	Healthy	Early stage of disease	Middle stage of disease	Advanced stage of disease
Aspartic acid	+	+ +	+ + + +	+ + +
Serine ..	+	+ +	+ + +	+ + +
Glycine ..	+ +	+ +	+ + +	+ + +
Glutamic acid	+ +	+ +	+ + +	+ + +
Threonine..	+	+ +	+ + + +	+ + +
Alanine ..	+ + +	+ + +	+ + +	+ + +
Tyrosine ..	Trace	Trace	+	Trace
Valine, methionine	+	+	+ +	+
Leucines ..	+	+	+	+ +
γ-amino butyric acid	+ +	+ + +	+ +	+ + +
Proline ..	Trace	Trace	Trace	Trace
Methionine sulphoxide	Trace	Trace	Trace	Trace
Glutamine..	+	+ +	+ + + +	+ + +
Asparagine	+ + +	+ + +	+ + + +	+ + +
Cystine ..	Trace	+	Trace	Trace
Lysine ..	+	Trace	Trace	Trace
Histidine ..	Trace	Trace	Trace	Trace
Arginine ..	Trace	Trace	+ + +	+ + +

Results presented in Table I indicate accumulation of aspartic acid, serine, glycine, glutamic acid, threonine, glutamine, asparagine and arginine in tender leaves as the disease advances to the middle stage when all the typical disease symptoms are fully manifested on the foliage.

There does not appear to be any further increase with the progress of the disease. Asparagine is found to be present in comparatively higher levels in the diseased leaves than the other amino-acids and amides. Arginine increases from traces in the healthy and early stages of disease to considerable amounts in the middle and advanced stages of the disease.

This abnormal metabolism of amino-acids and amides noted in infected palms is comparable to similar conditions reported in many virus-infected plants.[4,5]

The frequent association of leaf rot with root (wilt) disease in coconut palms may be due to the high content of free amino-acids found in tender leaves of wilt-infected palms since susceptibility to fungal pathogens is known to be increased with increasing quantity of free amino-acids in plant tissues.

The authors are thankful to Dr. S. B. Lal for his encouragement and valuable suggestions in the preparation of this note.

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A NOTE ON THE OCCURRENCE OF BASTITE

Bastite was first found in "Schillerfels" from Baste near Harzburg in the Harz Mountains, Germany. It is characterized by a bronze-like luster or *schiller* on the chief cleavage face *b* (010) and hence it is also called "Schillerspar".

Bastite occurs in foliated or fibrous form in granular basic eruptive rocks such as harzburgite and gabbro. Tröger writes that the orthopyroxene, by intake of water, is serpentinized during the hydrothermal stages of alteration, thereby becoming antigorite in the form of "shaggy" aggregate or also oriented "Bastite" pseudomorphs.[3]

Winchell[6] describes bastite as a coarse variety of antigorite, which is pseudomorphous after pyroxene, usually enstatite, but sometimes diopside.

The present investigations on the flaser-gabbro group of rocks from the Granulite Mountains, Saxon, Germany, reveal that the bastite occurs as pseudomorph after augite. The flaser-gabbro group of rocks are genetically related to the associated serpentinites which are believed to be differentiated from a pre-Variscan "Ophiolitic" magma according to Scheumann.[4] They are strongly deformed and metamorphosed with variable intensity. The ferromagnesian minerals are chloritized, uralitized and serpentinized. On the basis of their textural and mineralogical variations, the flaser-gabbro group of rocks are subdivided into several types. Those in which bastite appears as pseudomorph after augite are meta-gabbros, meta-gabbrodiorites (mafic meta-diorites), flaser-gabbros, flaser-gabbro-diorites, uralite-gabbros and uralite-gabbro-diorites.

The constituent minerals of these rocks are labradorite-andesine, monoclinic pyroxene (augite and diallage), bastite, hornblende-uralite, apatite and opaque minerals (pyrrhotite and magnetite). The modal analysis on twenty micro-sections shows a variation from 1 to 39% in the volume percentage of bastite. Ortho-pyroxenes are absent in these rocks and bastite is found always as pseudomorph after augite.

It is difficult to distinguish bastite from augite under polarised light but under crossed nicols bastite is characterized by its fibrous nature and grey interference colours. It exhibits straight extinction with reference to the direction of development of fibres, which are often oriented parallel to the slow direction of vibration and is optically negative in character.

The optic axial angles of bastites from the flaser-gabbro group of rocks of Saxon, Germany, were determined and the frequency distribution of $2V_x$-values is shown in Table I and in Fig. 1, from which it is seen that the $2V_x$-values vary from 50° to 80° and that the values between 55° to 60° are the most frequent.

Deer *et al.*[2] give the value for antigorite as between 37° to 60°, while it varies from 20° to 90° according to Schüller.[5] Deer *et al.*,[2] however, write that "the bastite crystals are not anti-goritic".

The optic axial angles of bastite do not show any characteristic differences in their values, even though the pyroxenes from which bastite is formed, show a variation from 36° to 72° in the $2V_z$-values.

The extinction angles for bastite were determined, using sometimes the relict cleavage of augite, following the method described by Burri.[1] The Z Λ c values vary from 0° to 39°,

TABLE I

Frequency distribution of $2V_x$-values of bastite in the flaser-gabbro group of rocks

Rock-type	$2V_x$-Values						
	50°–55°	55°–60°	60°–65°	65°–70°	70°–75°	75°–80°	
Meta-gabbros and -diorites ..	4	8	4	3	1	1	=21
Flaser-gabbros and -diorites ..	10	10	2	2	1	2	=27
Uralite-gabbros and -diorites..	3	9	..	..	..	..	=12
No. of Determinations ..	17	27	6	5	2	3	=60
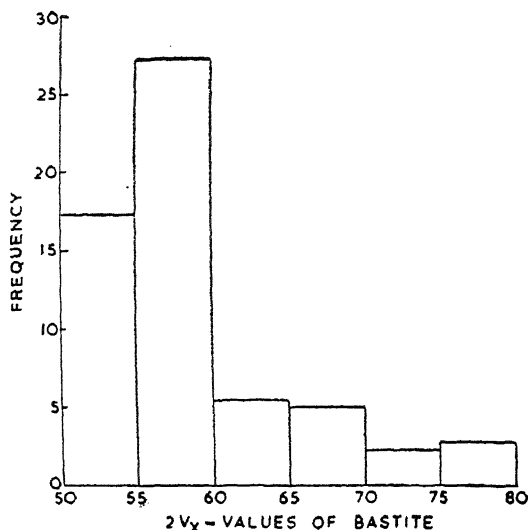
FIG. 1. Histogram representing the frequency distribution of $2V_x$-values of Bastite.

which may further support that bastite is formed from augite.

Geology Department,   A. V. R. SASTRY.
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NOTE ON UCHICH SILVER MINES (KULU), KANGRA DISTRICT, PUNJAB

EXISTENCE of alleged silver mines near Manikaran in Kulu Subdivision, Kangra District, was recorded by J. Culvert in his trevelogue, 'Vazeeri Rupi the Silver Country of Vazeers in Kulu, etc. (1873)'. The mines had been later visited by several geologists but no detailed investigation seems to have been undertaken to evaluate the economic potentiality of this occurrence. In 1960 an officer of the Indian Bureau of Mines visited the mines and consequent to his report the Geological Survey of India initiated detailed geological investigations by the present writer, in 1961-62.

Rocks in the area may be divided into two main groups, namely, the schistose series comprising garnetiferous schists, mica schists and bands of gneisses with slates, phyllites and quartzites and occasional bands of carbonaceous schists, and the quartzite-phyllite series comprising massive quartzite, phyllites, slates, chlorite phyllites, etc. The later formation underlies the schistose series which exhibits higher grade of metamorphism and appears to be thrust over the quartzite-phyllite series.

The Uchich mines, named after the village near the mines, are located in the massive quartzite about 60 metres from its contact with overlying series. There are two old workings situated at a vertical distance of about 70 metres from each other. The upper one is situated on a dangerously steep slope on the right bank of the Parvati river below the Uchich village (32° 1' : 77° 21') and opens on the vertical cliff facing the river. The lower one is situated on the river-bed on the right flank of the river and was worked in four levels.

Both the workings are located along apparently NW-SE shear zone. The upper and lower mines show lodes striking N 20° W and N 40° W respectively. They have been worked to 19 metres and 16·5 metres respectively and are about 1 to 1½ metres in width. In the upper one

the ore-body is apparently lenticular with its maximum width in the central part (0·76 metre), pinching out to about 10 cm. at both ends.

Quartzite, enclosing the ore-bodies, is highly fractured and jointed. Wall rock alteration is not marked. Along shear planes passing along the roofs of both the mines, however. pockets of ash-coloured kaolinised material containing stringers and disseminations of pyrite arc observed. Near the entrance to the mines is observed 1·5 metres thick outcrop of siliceous breccia filled with dark cryptocrystalline material showing very fine disseminations of pyrite and arsenopyrite.

The mineralisation apparently occurs as lenticular lodes arranged in en-echelon pattern in a fractured zone within the quartzite. Vertical extension of mineralisation is indicated by disseminations of pyrite and some galena in the quartzite along the cliff face below the upper mine. The mineralisation at depth appears to be diminishing in intensity as well as in grade. Maximum width of mineralised zone met within the borehole No. III was about 37 cm. as against 76 cm. in the upper mine.

Megascopically the ore from the upper mine shows an assemblage of pyrite, arsenopyrite and some galena with quartz as gangue material. In the lower mine the ore is predominantly pyritic with some stringers of galena in the quartzite. In polished section the ore is found to be predominantly pyrite with some arseno-pyrite and galena. Mineral grains vary from 0·009 mm. to 0·5 mm. and are highly fractured, brecciated and pulverised. Specimens from the lower mine, however, showed less brecciation, the grains being cut by a network of fractures.

Spectroscopic analysis showed As, Sb, Pb, Ag and Cu as minor constituents. The average grade of the ore, analysed in Indian Bureau of Mines laboratory, is, Au 0·19 dwt. and Ag 24·84 dwt. per short ton, Pb 2·87%, S 21·26% and As 9·88%. Some samples from the lower mines showed ·7 and 14% Pb for channel lengths of 30 cm. and 60 cm. respectively. The average grade of ore from lower mine is however very poor compared to the upper mine.

Narrow width and possible lenticular mode of occurrence, signs of diminishing grade and intensity of mineralisation with depth and lack of evidence of strike continuity of the ore bodies do not hold out promise of an economically workable deposit at Uchich at this stage. Further, exploration of this area by geophysical surveys and drilling is necessary to locate similar small occurrences in order to assess the economic potentiality of the area as a whole.

ON THE INTRA-CELLULAR LOCALISATION OF ALKALINE PHOSPHATASE IN THE OVARY OF DOG

The ovary was removed in the living condition from anæsthetised dog and fresh frozen sections were cut at 10 μ. These sections were processed by Gomori's technique for alkaline phosphatase.[1]

It is interesting to note that the results show localisation of enzyme exclusively at the periphery of the oocyte (arrows in Fig. 1). In
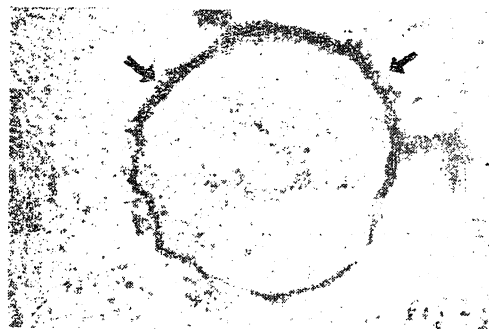

FIG. 1

other words the positive area is the area of zona pellucida which forms the boundary between the follicular cells and the oocyte proper. The nucleus and the other parts of the cytoplasmic area are completely devoid of the enzymatic activity. It is further seen that the follicular cells, constituting a multicellular layer around the oocyte, are also negative for the enzyme.

It has been suggested that nutrient materials pass from the follicular cells to oocytes.[2,3] Further it has been shown in a variety of cells that the alkaline phosphatase at the cellular membranes has a significant metabolic role in the process of permeability across the membranes.[4-6] In this context the localisation of alkaline phosphatase at the zona pellucida acquires a special significance. There is strong possibility that in the present case the alkaline phosphatase might be playing the metabolic role in facilitating the transference of substances across the zona pellucida from follicular cells to the oocyte.

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R.N.T. Medical College   SHRI GOPAL KABRA.
   and Zoology Dept. of
   University of Udaipur,
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OCCURRENCE OF A NEW SPECIES OF *SCHISMATORHYNCHUS (NUKTA)* IN THE RIVER GHAGGAR NEAR CHANDIMANDIR (PUNJAB)

THE genus *Schismatorhynchus* has been reported from the freshwaters of Indo-Australian Archipelago[5] and from the rivers of the Indian Peninsula.[1-4] Its occurrence in this part of the Indian sub-continent is of considerable zoogeographic significance.

FIG. 1

Hora[3] divided the genus *Schismatorhynchus* into two subgenera, *Schismatorhynchus* for *S. heterorhynchus* (Blkr.) and *Nukta* for *Cyprinus nukta* Sykes, the former found in the freshwaters of Sumatra and Borneo and the latter in the rivers of the Peninsular India. He stated that *Schismatorhynchus* of the Peninsular India is subgenerically different from the Indo-Australian form. The main differences are the continuation of the lower lip with the upper lip and the absence of the rostral barbels. Other obvious differences are the number of the lateral line scales which are 37 to 38 in *S. (Nukta) nukta* (Sykes) as compared to 33 in *S. heterorhynchus* (Blkr.) and the form of proboscis.

The present specimens resemble *S. (Nukta) nukta* in the absence of rostral barbels and continuation of the upper lip with the lower lip. However, they differ from *S. (Nukta) nukta* in having 42 scales on the lateral line and $7\frac{1}{2}$ rows of scales between it and the insertion of the ventral fin as compared to $4\frac{1}{2}$-5 rows of scales in *S. (Nukta) nukta*. Moreover the arrangement of tubercles is symmetrical on the lower and upper portions of the snout, and the proboscis is more like *S. heterorhynchus* than *S. (Nukta) nukta*. The depth of the body and other morphometric characters also show differences from other known species of *Schismatorhynchus*.

Based on the scale counts, form of proboscis and other morphometric characters I am inclined to think that the present specimens belong to a new species of *Schismatorhynchus (Nukta)*. The details are being studied and will be published elsewhere.

I am thankful to Mr. P. K. B. Menon, Curator of the Museum, for confirming my observations and helpful suggestions.

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ON THE GENUS *SCOTOZOUS* DOBSON (CHIROPTERA: VESPERTILIONIDAE)

THERE has been considerable confusion regarding the definition, taxonomic status and affinities of the group of species referred by various authors to the genus *Scotozous*. In the original description of the genus Dobson[1] included only one species, *S. dormeri* Dobson, and mentioned the second upper incisor (i^2) as absent. Later he[2] suggested the relationship of the genus to some African forms. Miller[3] referred to the reduction (not absence) of i^2 in the group and included some African forms in it. Thomas[4] referred to variable presence of i^2 in the genus. Wroughton[5] apparently followed Miller in providing a key to the Indian Chiroptera. Tate[6] restricted the genus to the Indian forms and emphasized the general absence of i^2 in the group and other important

characters distinguishing it from the African forms. Ellerman and Morrison-Scott[7] accorded the group a subgeneric status under the genus *Pipistrellus* including in it both Indian and African forms. Brosset[8] stated that i^2 is absent in the group but apparently considered it only a species of the genus *Pipistrellus*.

Besides the confusion caused by the above conflicting views, the practical difficulty is that a worker, undertaking identification work, generally consults only the keys provided in important basic works such as Miller[3] and Wroughton[5] without consulting original descriptions and these works can be of no help in the identification of *S. dormeri*, a very common Indian species, because there is no mention in them of the absence of i^2 in the species. The difficulty was felt by Brosset[8] and personally by me.

In view of these difficulties forty skulls of specimens collected around Jabalpur city were examined and it was found that only one had i^2 in a rudimentary form hardly visible with the naked eye (Fig. 2). In two subadult skulls its place was occupied by the milk tooth, Mi^2 (Fig. 1). This shows that at least in the nomi-

FIGS. 1-2. Fig. 1. A part of the lateral view of subadult skull of *Scotozous dormeri* Dobson showing a milk tooth (Mi^2) in place of permanent second upper incisor, × 5. Fig. 2. A part of lateral view of an adult skull of *Scotozous dormeri* Dobson showing the minute second upper incisor (i^2), × 5.

nate race, this tooth in permanent dentition can be considered as practically absent and the species may with justification be referred to a separate genus, *Scotozous* (*vide* Khajuria[9]). With respect to this most important distinguishing character, the genus may, thus, be defined as follows : i^2 in permanent dentition practically absent ; when very rarely present, very minute, hardly visible with naked eye, and not extending beyond the cingulum of first upper incisor.

The true nature of the character is being illustrated for the first time.

Perhaps the only character suggesting the affinities of *Scotozous* with the African *Pipistrellus ruppelli* Fischer is the considerable reduction in the size of i^2 in the latter but several other characters of African species (Tate[6]) appear to show that the relationship may better be considered at the generic level.

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ON A RARE PARASITE *CAPILLARIA NYCTICEIUSI* N.SP. (NEMATODA : TRICHURIDAE) FROM *NYCTICEIUS KUHLII*
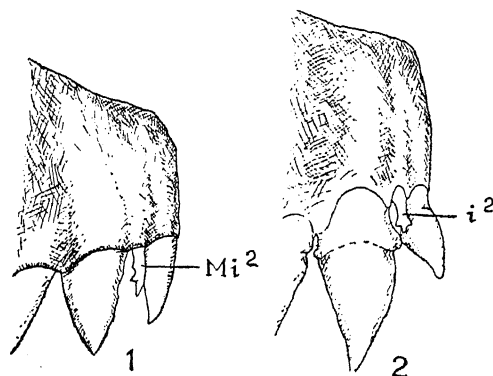
ONLY two male and six female specimens of this form were collected from the intestine of a bat, *Nycticeius kuhlii* Rafinesque, 1819.

Capillaria nycticeiusi N. SP.

Description

Body very slender (Fig. 1) without cuticular bosses ; œsophageal portion shorter and slightly thinner than posterior portion. Mouth simple without definite lips. Vulva pre-equatorial (Fig. 3), a little posterior to œsophagus provided with a protrusible funnel-shaped appendage. Posterior end of female (Fig 5) cylindrical and sub-terminal. Eggs thick barrel-shaped (Fig. 6); plugs very broad ; innermost egg shell bent to form a collar. Caudal end of male (Figs. 2, 4) supported by three slender rays, each of which bears a terminal papilla. Spicule long, slender enclosed in a transversely striated smooth sheath. Anterior end of spicule an open funnel and posterior end bluntly rounded and narrow. Cloacal aperture terminal. Ratio of œsophageal to intestinal region about 1 : 3 in both sexes.
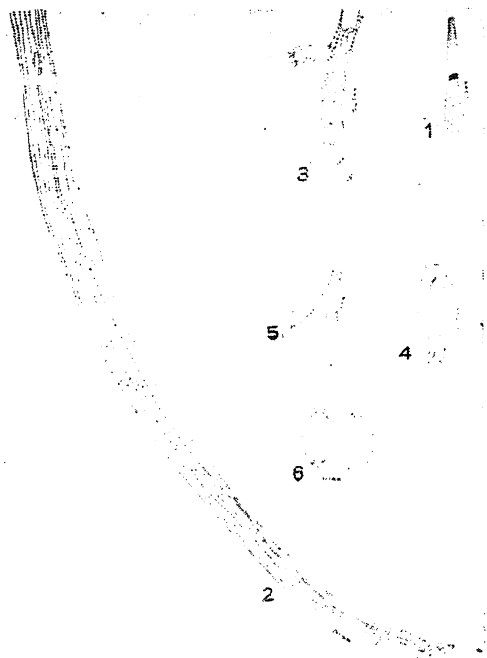
Male.—Body 8·6 to 9·4 mm. long, 0·045 to 0·05 mm. in maximum width. Distance to nerve ring from anterior end of body 0·076

to 0·085 mm. Length of œsophagus from anterior end, 3·03 to 3·2 mm. and from posterior end 5·57 to 6·2 mm. Spicule 1·15 to 1·23 mm. long. 0·018 mm. in width. Bursa-like apparatus present, 0·029 to 0·031 mm. in diameter.

FIGS. 1–6. *Capillaria nycticeiusi*, n. sp. Fig. 1. Anterior region of female, lateral view. Fig. 2. Posterior end of male, lateral view. Fig. 3. Vulvar region, lateral view. Fig. 4. Posterior end of male, ventral view. Fig. 5. Posterior end of female, lateral view. Fig. 6. Eggs.

Female.—Body 9·37 to 14·34 mm. long, 0·11 to 0·12 mm. in maximum width. Distance to nerve ring from anterior end of body 0·063 to 0·078 mm. Length of œsophagus from anterior end 3·22 to 4·05 mm. and from posterior end 6·11 to 10·29 mm. Vulva pre-equatorial a little posterior to œsophagus 3·32 to 4·15 mm. from anterior end. Eggs measure 0·26 to 0·28 × 0·14 to 0·16 mm. in size.

No form of this genus has been recorded so far from bats in India. The genus *Capillaria* Zeder, 1800. in bats comprise the following species, *viz.*, *C. vespertilionis* (Rud., 1819) Trav., 1918[6]; *C. pintoi* Freitas, 1934[4]; *C. pulchra* (Freitas. 1934) Lopez Neyra, 1947[1,4] *C. brasiliana* (Freitas, 1933) Skrjabin *et* Schikhobalova, 1954[2,3]; *C. angrensis* (Freitas, 1934) Skrjabin *et* Schikhobalova, 1954[2,4] and *C. miniopterœ* Thomas, 1959.[5] The new form resembles *C. vespertilionis, C. pintoi, C. angrensis* and *C. miniopterœ* in the

possession of a vulvar appendage in the females. It differs from *C. miniopterœ* in the possession of a spicule and in the absence of preanal algæ in the males. The new form differs from *C. vespertilionis, C. pintoi* and *C. angrensis* in having a long spicule, in the number and arrangement of anal papillæ and in the possession of three slender rays at the posterior end of male in a bursa-like apparatus. The new form is also distinguished from *C. vespertilionis* in the possession of a smooth sheath. These differences are sufficient to create a new species with the specific name *C. nycticeiusi.* n. sp.

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NOTES ON SOME FOSSIL SCLEREIDS

WHILE studying the anatomy of some petrified fossil woods from the Rajmahal Hills (Jurassic), some thick-walled isolated cells of various shapes and sizes were noticed therein. These look very much like sclereids found in the living forms. Earlier mention about the occurrence of similar cells in fossils is under various names like "sclerotic nests", "sclerenchymatous idioblasts," "stone cells", etc. But recent studies of living plants have shown that they cannot all be grouped under the same category. Sclereids are parenchymatous cells, non-prosenchymatous in origin and are secondarily sclerosed to form variously shaped idioblasts. A careful study, so far as we are aware, has not been made of the sclereids of fossil plants. Such sclereid characters in fossils may, along with the other morphological and anatomical characters, prove to be of diagnostic importance as in living forms.[1,2] With this in view, a preliminary study of sclereids in three petrified plant remains from Rajmahal Hills was made.

In the cortex and pith of *Brachyphyllum* shoots, numerous sclereids occur diffusely

(Photo 1). Some are more less isodiametric, lobed, or oval *brachysclereids*[3] (Figs. 1-3). Others are elongated, bone-shaped, or T-shaped *osteosclereids* (Figs. 4-6), while the majority are variously branched *astrosclereids* (Photo 2 and Figs. 7 and 8). The secondary wall of these sclereids is very thick, lignified, lamellated and has numerous crystals embedded in it (Figs. 1-3, 5, 7 and 8). The lumen narrows down in the sclereid branches and may also contain some crystals. The nature of these crystals cannot be determined in fossil forms, but these may be of calcium oxalate as are found in living plants like *Nymphœa*,[1] *Araucaria*[2] and *Agathis*.[5]
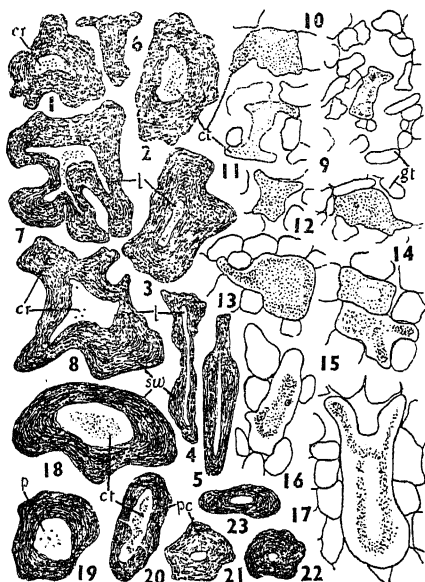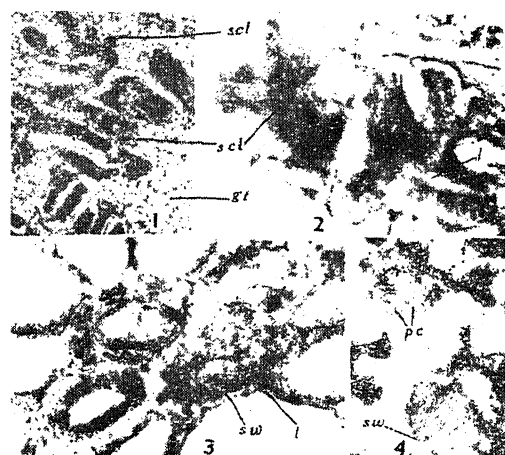

FIGS. 1-23. Figs. 1-8. Various types of sclereids in *Brachyphyllum* shoot, × 132. Figs. 9-17. Some developmental stages of sclereids in *Brachyphyllum* shoot, × 132. Figs. 18-20. Brachysclereids in *Ptilophyllum cutchense*, × 300. Figs 21-23. Brachysclereids in the unidentified conifer stem, × 132. (*cr*, crystal; *ct*, cell content; *gt*, ground tissue; *l*, rumen; *p*, pit; *pc*, pit canal; *sw*, secondary wall).

All developmental stages of various types of sclereids could not be traced for want of suitable material, but some younger stages were observed in a section of the primary shoot. The initials could be recognised by their large size and seemingly dense contents as compared with the neighbouring cells (Fig. 9). Small delicate arms from similar initials carrying the migrated protoplast, penetrating into the surrounding tissue may also be recongnised

(Figs. 10-15). The concentration of the protoplast towards the inner side of the lumen leading to the beginning of secondary wall formation could also be seen (Figs. 16 and 17). Evidently, from such initial stages, are differentiated the brachy, osteo and astrosclereids as in living forms. A small denser mass seen in the protoplast may well mark the position of the nucleus (Figs. 9, 12, 14 and 16). The genus *Brachyphyllum* has been compared to the living genus *Araucaria*.[6] The sclereids in their structure and distribution pattern closely resemble those of *Araucaria*.[2] The occurrence of polymorphic sclereids, presence of numerous crystals and absence of pit-canals in their secondary wall are other features of resemblance. This lends a little further support to the comparison between the living *Araucaria* and fossil *Brachyphyllum*.

Sclereids were also found in the rachis (Photo 3) and pinna of *Ptilophyllum cutchense* Morris, either occurring singly or in groups in the ground tissue, forming round the vascular bundles, a more or less continuous ring along with other mechanical tissues. In the pinna, they occur mostly in the palisade and rarely in the spongy mesophyll. The sclereids are mostly rounded, or oval, slightly elongated or roughly isodiametric, with thick, lignified lamellated secondary walls (Photo 3) traversed by pit-canals (Figs. 19 and 20) and containing

PHOTOS 1-4. Photo 1. Part of a longitudinal section of the shoot of *Brachyphyllum* showing a group of sclereids, × 82·5. Photo 2. Two sclereids magnified to show the lamellated wall and the narrow lumen., × 66. Photo 3. Four sclereids enlarged to show the lamellated wall, × 97. Photo 4. Sclereids in the pith region of the unidentified conifer stem, × 88. (*gt*, ground tissue; *l*, lumen; *pc*, pit-canal; *scl*, sclereid; *sw*, secondary wall.)

some substance in the lumen (shrivelled protoplast or wall substance ?). These are the brachysclereids. Similar looking, thick-walled cells have been shown by Sahni[7] in the peduncle and leaf bases of *Williamsonia sewardiana*, under the name *stone-cells*.

In another unidentified conifer stem, many sclereids are present in the pith region (Photo 4) and a few occur just outside the secondary phloem in the cortical tissue. The brachysclereids in the pith region are mostly rounded, polygonal or oval (Figs. 21 and 22) and the ones from the cortex are slightly elongated (Fig. 23). The mature sclereids are generally empty, with thick, lignified, lamellated secondary walls, traversed by a few pit-canals. These sclereids from their structure and distribution can be compared to those of the living genus *Podocarpus*.[8]

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COMPSOPOGON IYENGARII KRISHNAMURTHY FROM GUJARAT

OUT of six known species of *Compsopogon*, three species *C. cœruleus* (Balbis) Montagne, *C. hookeri* Montagne and *C. iyengarii* Krishnamurthy have been recorded so far from India: *C. cœruleus* from West Bengal, Orissa, Rajasthan and South India; *C. hookeri* from Madras, Cuttack and Calcutta and *C. iyengarii* from Madras.[1-5] *Compsopogon* has not been recorded from Gujarat.

Present material was collected in October, 1962, from Koteshwar near Ambaji. It was found attached to stones, in running water near Sarswati Mukh and was growing mixed with

Dichotomosiphon tuberosus Ernst. For detailed study, the material was again collected in the last week of February, 1965, from the same locality. It was growing epiphytically on the roots of *Phœnix* which were exposed in the running water.

The plants are greenish-blue. They are heterotrichous. The prostrate-disc-like portions with single erect filaments are up to 66·0 μ and those from which 2–6 filaments arise, reach up to 550·0 μ in thickness (Figs. 1 and 2). The
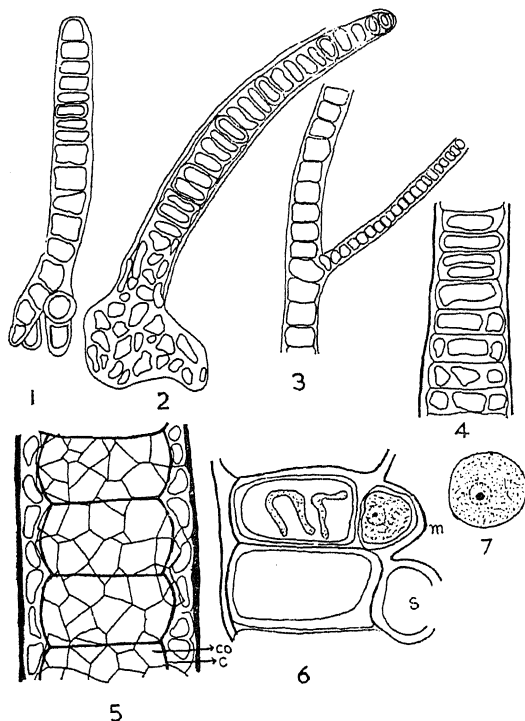
FIGS. 1–7. Figs. 1–2. Plants with basal portions and single erect filaments, × 230. Fig. 3. Part of the plant with a branch, × 15. Figs. 4–5. Portions of the filaments showing central cells (*c*) and cortical cells (*co*), × 230. Fig. 6. Monosporangium with monospore (*m*) and empty sporangium (*s*), × 500. Fig. 7. Single monospore after the liberation from the monosporangium, × 500.

filaments are up to 14·0 cm. in length in the material collected in October and up to 6·0 cm. when collected in February. They are unbranched or sparsely branched. The branches arise singly and are either on one side or alternate (Fig. 3). In one case, five to six branches were seen emerging near the base of the main axis. The branches make small angle with the main filament. Central row of axial cells of a mature filament is surrounded by one to three layers of peripheral or cortical

cells. In mature plants, new layers of large cells, inner to cortical cells, are seen towards the centre. The basal portion of the filament is not surrounded by the cortical cells, but multicellular rhizoids are developed around the central axis.

Cells of the uniseriate filaments are $22\cdot0$–$37\cdot0\,\mu$ in diameter and $4\cdot0$–$9\cdot0\,\mu$ in height (Figs. 1 and 2). In general, the main filaments are $255\cdot0$–$660\cdot0\,\mu$ in thickness (Figs. 4 and 5). The central large cells of the main axis are $217\cdot0$–$255\cdot0\,\mu$ broad and $97\cdot0$–$165\cdot0\,\mu$ long (Fig. 5). The cortical cells observed in surface view are $19\cdot0$–$28\cdot0\,\mu$ high and $17\cdot0$–$19\cdot0\,\mu$ broad (Fig. 5). The chromatophores are elongated, lobed and thread-like.

The monospores are $16\cdot0$–$20\cdot0\,\mu$ in diameter (Figs. 6 and 7).

In writer's collections, both in October and February, no microaplanospores were observed as reported by earlier workers.[4,8] The monospores were liberated when the material was transferred to the fresh culture medium or when the temperature of the culture was high. No sexual organs or tetraspores as reported by Flint[9] have been seen in the present material.

The present material is similar in general appearance, branching, etc., to *C. iyengarii* described by Krishnamurthy[2,3] from Madras. But the Gujarat alga is more robust, has a larger basal disc, thicker filaments and larger cell dimensions.

I am indebted to Principal J. G. Chohan and Dr. J. J. Shah for the facilities and encouragement.

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MOSAIC DISEASE OF *AMARANTHUS*—A NEW RECORD FOR INDIA

A SEVERE mosaic disease of *Amaranthus blitum* L. and *A. viridis* L., locally known as 'Cholai' and used as green vegetable, has been observed during summer months in several parts of Delhi and adjacent areas. The disease is characterised by a distinct mosaic mottle in young as well as the old leaves. The extent of symptom expression varies from severe yellowing of veins to large, irregular chlorotic patches alternating with dark green areas over the entire lamina. The mottling is usually very marked and the infected plants can be located even from a distance.

To determine the viral nature of the disease, scions showing severe symptoms were wedge-grafted on the stocks of *Amaranthus viridis* raised and maintained under insect-proof conditions. Characteristic symptoms appeared on the leaves emerging below the graft union in 10 to 15 days at a temperature of 29° to 40·5° C. Viral nature of the disease thus became apparent. To study the mechanical transmissibility of the virus, sap was extracted from severely infected leaves and inoculations made on healthy seedlings of *A. viridis* and *A. blitum* using carborundum as an abrasive. Symptoms started appearing within 90 to 160 hours after inoculation at a temperature of 29° to 45° C. They consisted of mild puckering of the inoculated leaves followed by yellowing of veins and finally a mosaic mottle. About a month after inoculation the mottling became intense and various mosaic patterns could be seen (Fig. 1).

FIG. 1. Leaves of *Amaranthus blitum* showing various patterns of mosaic mottle; Healthy leaf on extreme left.

The virus could also be transmitted by sap inoculation to *Amaranthus cruentus* L., *A. dlitum* L. IC 4673, *A. gangeticus* L., *A. leucarpus* L., and *A. mangostanus* L. Intense mosaic mottle was discernible on all these species of *Amaranthus* at a temperature of 29° to 46° C. The virus could not, however,

be transmitted at the above range of temperature to the following plant species which include indicators of a large number of plant viruses :

Nicotiana tabacum L. vars. Harrison's Special and White Burley, *N. glutinosa* L., *Solanum melongena* L., *Capsicum annuum* L., *Chenopodium amaranticolor* Coste and Reyn, *Gomphrena globosa* L., *Beta vulgaris* L., *Cyamopsis tetragonoloba* L., *Crotalaria juncea* L., *Acalypha indica* L., *Helianthus annuus* L. and *Datura stramonium* L. Back inoculations proved that none of them is a symptomless carrier.

This constitutes the first record of a virus disease on *Amaranthus* in India. There is also no record from anywhere of any virus disease affecting the species of *Amaranthus*, excepting *A. gangeticus* susceptible to the virus under study. Some workers[1-10] have reported other species of *Amaranthus* susceptible to some viruses of other crops. From the host range reported above, the present virus appears to be distinct from other viruses infecting species of *Amaranthus*.

The author wishes to record his grateful thanks to Dr. S. P. Raychaudhuri for guidance.

Division of Mycology and   H. C. PHATAK.
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Indian Agricultural
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  * Original not seen.

LIME AND PHOSPHATE DEPOSITS IN LACCADIVE ISLANDS

THE Arabian Sea islands otherwise called as LMA islands are made up of 19 islands, situated 150–200 miles away from Kerala coast. They are coral islands, surrounded by shallow lagoons on three sides. Coconuts and bread fruit grow almost wild with profuse bearing. The soil is white to dark brown, sandy, single grain and

contain large proportions of broken shells, corals, etc. It is almost devoid of organic matter. Preliminary analysis of these soils showed high values for phosphoric acid and calcium carbonate. So a detailed soil survey of these islands was conducted to assess their nature and distribution.

Representative surface samples were collected by the author from all the islands and analysed for plant food elements. The distribution of phosphoric acid according to particle size and its solubility in citric acid was also studied, using standard methods as per AOAC, 1951.

The results of the analysis are presented in Table I with their range in variation.

TABLE I

Locality	N_2%	P_2O_5%	K_2O%	$CaCO_3$%	MgO%	SiO_2	Fl
Kalpeni ..	Trace	5–12	Trace	70–80	0·1	..	..
Androth ..	do.	4–5	..	80–85	..	..	..
Ameni ..	Nil	4–5	..	80–85	..	..	..
Kiltan ..	Trace	8–10	..	75–80	..	..	..
Chetlat ..	do.	10–22	..	60–75	..	..	..
Bitra ..	do.	20–25	..	60–75	..	..	..
Agathy ..	do.	3–5	..	80–85	..	..	..
Kavarathy ..	Nil	1–2	..	85–90	..	..	..
Pitty ..	Trace	18–30	..	80–90	..	..	..

Soils of Kalpeni contain MgO of about 0·1%. Silicates and fluorides are totally absent in all the samples. Potash and nitrogen content varies from trace to nil. It can be seen from the data that calcium carbonate is the predominant portion of the soil with phosphoric acid in varying proportion. The distribution of total and citrate-soluble phosphoric acid according to particle size is presented in Table II.

TABLE II

Particle size	Total P_2O_5%	Citrate-soluble P_2O_5%	$CaCO_3$%
60	6	5·2	75
70	12	11·0	65
80	20	19·2	70
90	30	27·9	65

It is seen that the phosphate increases with the fineness of the particle and most of them are citrate-soluble.

The origin and occurrence of large proportions of phosphates in these soils are not conclusively traceable. It is very likely that these phosphates have been formed from the birds guano deposited through centuries. The fact that large number of birds perch on the uninhabited,

Pitty island, even now, gives sufficient support for this view. But the absence of nitrogen in these soils including the recent deposits in Pitty island is quite surprising. Perhaps the presence of $CaCO_3$ might have caused the complete loss of ammoniacal nitrogen and the nitrate nitrogen present, if any, might have been washed away. It is also interesting to note that the phosphate is not reverted back even in the presence of large quantities of calcium carbonate.

The author gratefully acknowledges the encouragement and directions given by Dr. C. K. N. Nair, Principal and Additional Director of Agriculture (Research), during the course of the work.

Agricultural College and   N. Subramony.
Research Institute,
Vellayani, *June* 30, 1965.

GERMINATION OF SPORES WITHIN THE SPORANGIUM OF *ANTROPHYUM PLANTAGINEUM* KAULF.

While studying the anatomy and life-history of *Antrophyum plantagineum* (Vittariaceæ), some stages of spore germination within the sporangium were encountered in the preserved, fertile material. Such *in situ* germination of spores is rather rare and does not seem to have been so far reported in *Antrophyum*. or for that matter, in the family Vittariaceæ. It was therefore thought desirable to record them in a brief preliminary note.

The stalked sporangium of *Antrophyum plantagineum* has an incomplete annulus of about 10–15 thick-walled cells and a stomium of four elongated cells with accessory cells above and below. The tetrahedral spores (Fig. 1), having a triradiate mark, measure approximately 44μ across. The exine (Fig. 2) is 7μ thick and has three layers. The innermost layer is the thickest and dark brown in colour, the middle one is light brown and equally thick while the outermost is thin and hyaline.

Germinating spores within the sporangium were observed in about 5% of the sporangia studied. The earliest stage (Fig. 3) shows that the exine has burst and the first gametophyte cell has been cut off. A lateral rhizoidal initial is seen in Fig. 4. The gametophyte initial elongates (Fig. 5) and divides into two cells (Fig. 6). Subsequent transverse divisions lead to a uniseriate filament of 3–5 cells (Figs. 7, 8), which are hyaline in colour with meagre protoplasmic contents. A unicellular rhizoid is also found attached. This is the maximum development of the gametophyte as

seen within the sporangium. No longitudinal divisions have been observed.
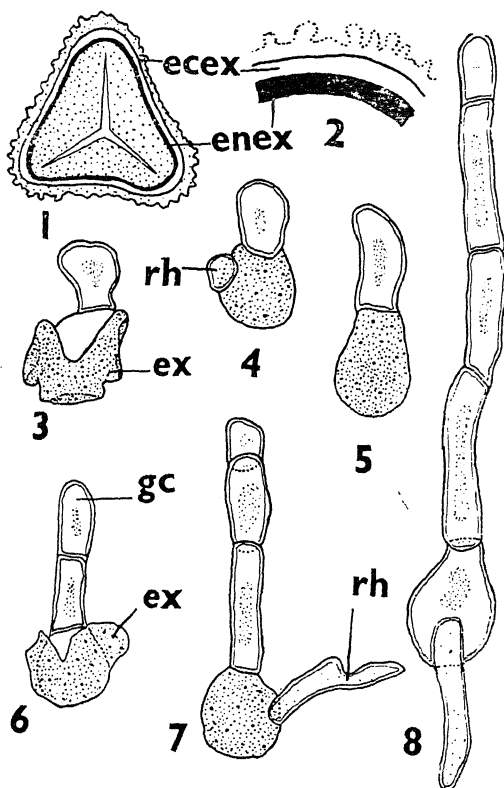
FIGS. 1–8. Fig. 1. A spore in polar view, × 375; Fig. 2. The exine structure, × 850. Figs. 3–5. Diagrams showing one cell stage of germination, × 175. Figs. 6–8. Diagrams showing stages in further development of the gametophyte, × 175. (*ex*, exine; *ecex*, ectoexine; *enex*, endoexine; *gc*, gametophyte cell; *rh*, rhizoid.)

Such spore germinations within the sporangium in nature have been observed by Stokey[3] in *Hymenophyllum* and *Trichomanes* and by Sharma[2] in *Mecodium badium*. The filamentous structure observed in *Antrophyum plantagineum* will probably divide later longitudinally to form the ribbon-shaped, one cell thick prothalli known in other members of the Vittariaceæ, *e.g.*, *Vittaria*, *Hecistopteris*, *Vaginularia* and *Polytœnium* (Copeland, p. 227).[1]

I am greatly indebted to Prof. A. R. Rao for his valuable guidance and to Dr. B. K. Nayar for helpful suggestions.

Department of Botany,   (Miss) Prem Khare.
Lucknow University,
Lucknow, India, *April* 29, 1964.

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2. Sharma, U., *J. Indian bot. Soc.*, 1962, **41**, 571.
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REVIEWS AND NOTICES OF BOOKS

Ways of Thought of Great Mathematicians. By Meschkowski. (Holden-Day—The Mathesis Series), 1964. Pp. viii + 110. Price : $ 5.95 cloth ; $ 3.95 paper.

To understand the fundamental problems of modern mathematics, one must first study the history of mathematics. However, it is not easy for a modern mathematician to approach the history of his discipline. It seems worthwhile to try to complement the invaluable comprehensive works (on one period or one person) with an approach to the history of mathematics of quite a different sort. The author in this volume has tried through fairly detailed discussions of a few examples, to bring to life the ways of thought of some mathematicians of earlier centuries : The table of contents of this book is as follows : The Pythagoreans ; Archimedes ; Nicholas of Cusa ; Blaise Pascal ; Gottfried Wilhelm Leibniz ; Carl Friedrich Gauss ; George Boole ; Weierstrass and his school ; Georg Cantor.

The bibliography given at the end of the book will stimulate the reader to further study.

C. V. R.

The Chemical Society : Annual Reports on the Progress of Chemistry (Vol. LX). (The Chemical Society, London W. 1), 1964. Pp. vi + 681. Price £ 2-0-0.

This well-known series is familiar to all chemists and is an indispensable companion to all those who are interested in chemical research. The whole field of chemistry is dealt with in six sections. The first section, viz., General and Physical Chemistry, contains eight articles, amongst which we may note with special interest the long article entitled "Progress in Infra-red and Raman Spectroscopy", by D. A. Long. The second section, Inorganic Chemistry, contains four articles. The third section, Organic Chemistry, contains thirteen articles, the fourth section, Biological Chemistry, contains five articles. the fifth section, Analytical Chemistry, also contains five articles, and the concluding section, Crystallography, contains three articles.

An author index and a subject index given at the end of this volume add greatly to its usefulness.

C. V. R.

Temporal Organization in Cells : A Dynamic Theory of Cellular Control Processes. By B. C. Goodwin. (Academic Press, New York and London), 1963. Pp. x + 163. Price 37 sh. 6 d.

The scope of this volume is indicated by the list of the titles of eight chapters given below : 1. Introduction ; 2. System and Environment ; 3. Control Systems and Rhythmic Phenomena in Cells ; 4. The Dynamics of the Epigenetic System ; 5. The Statistical Mechanics of the Epigenetic System ; 6. The Relaxation Time of the Epigenetic System ; 7. Statistical Properties of the Epigenetic System ; 8. Applications and Predictions.

C. V. R.

Standard Methods in Clinical Chemistry (Vol. 4). Edited by David Seligson. (Academic Press, New York and London), 1963. Pp. xiv + 261. Price $ 7.50.

The number of contributors to this volume is twenty-seven. The scope of the volume is indicated by the titles of the articles contained therein : Free Amino-Acids in Plasma and Urine by the Gasometric Ninhydrin-Carbon Dioxide Method ; Turbidimetric Measurement of Amylase : Standardization and Control with Stable Serum ; Identification of Urinary Tract Calculi by Infra-red Spectroscopy ; The Spectrophotometric Determination of Carbon Monoxide in Blood ; Ceruloplasmin Assay in Serum : Standardization of Ceruloplasmin Activity in Terms of International Enzyme Units ; Serum Cholinesterase ; Copper in Serum ; Urinary Estrogens ; Measurement of Total Esterified Fatty Acid and Triglyceride Concentrations in Serum ; Glucose (Enzymatic) ; Free and Conjugated 17-Hydroxycorticosteroids in Urine ; The Determination of 5-Hydroxyindoleacetic Acid in Urine ; Determination of Protein-Bound Iodine in Serum ; Serum Iron and Serum Iron-Binding Capacity ; Determination of Urinary Neutral 17-Ketosteroids ; Lactic Dehydrogenase ; Gravimetric Determination of Total Lipids in Blood Serum or Plasma ; Oxygen Saturation of Blood ; Determination of Serum Inorganic Phosphorus ; The Estimation of Serotonin in Biological Material ; Some Applications of Statistics to Clinical Chemistry ; Uric Acid.

C. V. R.

Beyond Newton. By Dewey B. Larson. (North Pacific Publishers, Portland 13, Oregon), 1964. Pp. 160. Price $ 5.00.

The subject-matter in this volume is dealt with in five parts whose titles are as follows : 1. The Problem ; 2. The Answer ; 3. The Theory ; 4. The Opposition ; and 5. Discussion.

C. V. R.

Compact Calculus. By Philip Franklin. (Mc-Graw-Hill Book Company, Inc., New York, San Francisco, Toronto, London), 1963. Pp. 245.

This book is a rigorous introduction to elementary calculus. It is shorter than most standard introductory texts, but contains much of the modern spirit. The reader is assumed to have studied trigonometry and to have done some work with graphs in his course in algebra.

The following is the table of contents of the book : 1. Functions, Derivatives, Limits ; 2. The Definite Integral as a Limit ; 3. Differentiation of Algebraic Functions and Logarithms ; 4. Trigonometric and Hyperbolic Functions, Differentials ; 5. Applications of Differentiation ; 6. Integration as Antidifferentiation ; 7. Geometric Applications of Definite Integrals ; 8. Physical Applications of Definite Integrals ; 9. Polar Co-ordinates, Curvature ; 10. Partial Derivatives, Multiple Integrals.

C. V. R.

Mathematics in Science and Engineering (Vol. 11). *Differential Forms with Applications to the Physical Sciences.* By Harley Flanders. (Academic Press, New York and London), 1963. Pp. xiii + 203. Price $ 7.50.

The scope of this book is indicated by the titles of the chapter headings given below : I. Introduction ; II. Exterior Algebra ; III. The Exterior Derivative ; IV. Applications ; V. Manifolds and Integration ; VI. Applications in Euclidean Space ; VII. Applications to Differential Equations ; VIII. Applications to Differential Geometry ; IX. Applications to Group Theory ; and X. Applications to Physics.

C. V. R.

Functions of a Complex Variable and Some of Their Applications (Vol. I). By B. A. Fuchs and B. V. Shabat. (Addison-Wesley Publishing Company, Inc., U.S.A. and London), 1964. Pp. xvi + 431. Price $ 10.00.

This book is intended to serve both as a text for senior-graduate students of science and engineering and as a reference for practising engineers wishing to increase their knowledge of theory.

The titles of the articles contained in this volume are as follows : Introduction ; The Fundamental Ideas of Complex Analysis ; Conformal Mappings ; Elementary Functions ; Applications to the Theory of Plane Fields ; The Integral Representation of a Regular Function ; Harmonic Functions ; Representation of Regular Functions by Series ; Applications of the Theory of Residues ; Mapping of Polygonal Domains.

C. V. R.

Introduction to Quantum Mechanics. By P. T. Matthews, F.R.S. (McGraw-Hill Publishing Company Ltd., Shoppenhangers Road, Maidenhead, Berks), 1964. Pp. xii + 170. Price 25 *sh.*

This volume is directed at students of physics, mathematics and theoretical chemistry. In addition, the material will arouse considerable interest among those attending courses in spectroscopy, nuclear physics, elementary particles, quantum theory of solids, and dislocation theory.

The titles of the articles contained in this book are as follows : Part I : Basic Formation— 1. Introduction ; 2. Operators ; 3. Quantum Mechanics ; 4. One-Dimensional Motion ; 5. The Harmonic Oscillator ; Part II : Atomic Physics—. 1. Angular Momentum ; 2. Central Potential : The Hydrogen Atom ; 3. Spin and Statistics ; Part III : Nuclear Physics— 1. Rutherford Scattering and α-Decay ; 2. Scattering Theory ; 3. The Nucleon-Nucleon Interaction ; Part IV : General Theory—1. Operators and State Vectors ; 2. Equations of Motion.

C. V. R.

Perturbation Methods in Fluid Mechanics (Vol. 8). *Applied Mathematics and Mechanics.* F. N. Frenkiel and G. Temple, Series Editors. Author : Milton Van Dyke. (Academic Press, New York and London), 1964. Pp. x + 239. Price $ 7.00.

The application of methods of successive approximation to non-linear equations of fluid mechanics is now given full exposition in this book. For the first time, a systematic account of the method of matched asymptotic expansions is furnished—and applied to viscous flows at high and low Reynolds number, thin airfoils, lifting wings, and transonic, supersonic, and hypersonic flows. Aeronauts, oceanographers, mathematicians, engineers, and scientists in a wide range of land-based operational fields will welcome this needed volume for its systematic

approach and its emphasis on techniques recently developed for treating singular perturbation problems.   C. V. R.

The Problem of the Minimum of a Quadratic Functional. By S. G. Mikhlin. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1965. Pp. ix + 155. Price $ 8.95.

The material contained in this monograph is concerned with the statement and solution of problems associated with the minimum of a quadratic functional. Such problems classically have their origin in the calculus of variations, but they are treated here by using the concepts of Hilbert Space, in particular the theory of linear operators in such spaces. In some instances, the author also utilizes the spectral theory of operators.

The subject-matter in this book is dealt with in four chapters whose titles are as follows : Statement and Solution of Variational Problems ; Certain Auxiliary Results ; Applications of the Variational Method to Equations of Elliptic Type ; Applications to Elasticity Theory.

A supplement by the author and a considerably enlarged bibliography cover work done on the general subject-matter of the book since the appearance of the Russian edition. This monograph will appeal to students and teachers of applied mathematics, physics and theoretical engineering.   C. V. R.

Noneuclidean Geometry (*Academic Paperbacks in Mathematics*). Edited by W. Magnus and A. Shenitzer. Author : Herbert Meschkowski. (Academic Press, New York and London), 1964. Pp. viii + 101. Price $ 2.45 ; Clothbound $ 5.50.

This book was first published in the German language under the title *Nichteuklidische Geometrie* and copyrighted in 1961 by FRIEDR, VIEWEG and SOHN, Braunschweig, Germany.

The subject-matter in this book is dealt with in ten chapters whose titles are as listed below : 1. On Proofs and Definitions ; 2. Hilbert's System of Axioms ; 3. From the History of the Parallel Postulate ; 4. Lemmas ; 5. The Poincare Model ; 6. Elementary Theorems of Hyperbolic Geometry ; 7. Constructions ; 8. Trigonometry ; 9. Elliptic Geometry ; and 10. Epilog.   C. V. R.

Differential Analysis. (Oxford University Press). 1964. Pp. vii + 253. Price Rs. 25·00.

This volume is a collection of nineteen memoirs of varying lengths on the subject of

differential analysis presented to a colloquium held at the Tata Institute of Fundamental Research, Bombay, from 7th to 14th January 1964. Those who participated in the colloquium included experts from different countries, notably France, India, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States. The purpose of the colloquium was to discuss recent developments in some aspects of (*i*) the theory of differential equations, (*ii*) analysis in the large and differential geometry, and (*iii*) differential topology. A series of lectures were given and followed by discussions.   C. V. R.

Finite Permutation Groups. By Helmut Wielandt. (*Academic Paperbacks in Mathematics*. Edited by W. Magnus and A. Shenitzer). (Academic Press, New York and London), 1964. Pp. x + 114. Price $ 2.45.

The recent great advance in the theory of abstract groups gives reason for re-examining the related role of finite permutation groups, in the view of the author—and it is a view to which the reputation of this noted mathematician gives more than ordinary importance. He collects in this volume the basic theorems on permutation groups, shows their usefulness in constructing abstract groups, and demonstrates their applications in such contexts as Galois and function theory.

The integration of recent developments, the "stream-lined" proofs of older theorems, and the inclusion of many theorems rarely available in text-books adds to the value of this book. The book will be found useful by instructors who desire a sound and economical means of giving students the benefit of this methodology.   C. V. R.

Understanding Physics Today. By W. H. Watson. (University Press, Cambridge), 1963. Pp. xiii + 219. Price 30 *sh*.

This book contains the results of the philosophical reflection by the author instigated by the desire to understand how it is that physics goes on with ever-increasing pace to reveal new structure in the world in which we live, while, on the other hand, the theoretical apparatus made use of seems to involve some philosophical confusion. To put it briefly, the book concerns itself with the natural philosophy of atomic phenomena. It is difficult to summarise the views of the author on the several topics handled and the reader must therefore do it for himself.   C. V. R.

One Two Three.... Infinity—Facts & Speculations of Science. By George Gamow. (Macmillan & Co., Ltd.), 1962. Pp. xii + 340. Price 16 *sh.* net.

The book originated as an attempt to collect the most interesting facts and theories of modern science in such a way as to give the reader a general picture of the universe in its microscopic and macroscopic manifestations, as it presents itself to the eye of today. Some chapters of the book are simple enough to be understood by a child, whereas others will require some little concentration and study to be completely understood. The contents of the volume are dealt with in four parts whose titles are as follows: Part I. Playing with Numbers; Part II. Space, Time and Einstein; Part III. Microcosmos; Part IV. Macrocosmos.

C. V. R.

Heat Engines and Applied Thermodynamics. By N. C. Dey. (Asia Publishing House, Bombay), 1964. Price Rs. 26·00.

This book is intended to cover both theory and practice of Heat Engines, and prepare engineering students to go into the practical field with not only a theoretical konwledge, but also the practical knowledge of machinery necessary for their maintenance and operation.

The following is a list of the titles of the chapters contained in this volume: Thermodynamics of Gases; Air Compressor; Entropy of Gases; Standard Air Cycles; Combustion of Fuels; Internal Combustion Engines; Steam; Steam Boilers; Boiler Mountings, Fittings and Accessories; Natural and Artificial Draught; Performance of Boilers; Entropy of Water-Steam; Steam Engines; Compound Engines; Steam Condenser; Steam Engine Valves.

An Appendix contains a conversion table to the metric system. A number of typical problems has also been solved in the metric system which will be a guide to the students to deal with other problems based on the metric system.

C. V. R.

Cytodifferentiation and Macromolecular Synthesis. Edited by Michael Locke. (Academic Press, New York and London), 1963. Pp. xi + 274. Price $ 10.00.

The present volume contains the contributions made by eminent scientists in this field to the Twenty-First Symposium of the Society for the Study of Development and Growth, held at Asilomar, California, June 1962. The titles of the contributions are given below: Cytodifferentiation and Macromolecular Synthesis, by Clifford Grobstein; Genetic Control of Protein Structure, by Charles Yanofsky; Genetic Repression, Allosteric Inhibition, and Cellular Differentiation, by Francois Jacob and Jocques Monod; Epigenetic Control of Specific Protein Synthesis in Differentiating Cells, by Clement L. Markert; Quantitative Studies of Protein Synthesis in Some Embryonic Tissues, by Heinz Herrmann; Chromosomes and Cytodifferentiation, by Joseph G. Gall; The Plastids: Their Morphological and Chemical Differentiation, by S. Granick; Organization and Disorganization of Extracellular Substances: The Collagen System, by Jerome Gross, Charles M. Lapiere and Marvin L. Tanzer; On Mechanisms of Elongation, by Paul B. Green; Tissue Interaction and Specific Metabolic Responses: Chondrogenic Induction and Differentiation, by James W. Lash.

C. V. R.

Primary Processes in Photosynthesis (*Advanced Biochemistry—A Series of Monographs*). By Martin D. Kamen. (Academic Press, New York and London), 1963. Pp. xii + 183. Price $ 5.50.

The author in this book has outlined the interrelation of the various disciplines by analysis of the photosynthetic process into successive "eras", so that the reader, whether a novice or a sophisticate, can obtain a useful perspective of the process as a whole. This, together with a statement of simple systematics, comprises the first chapter and sets the stage for the discussion of the photosynthetic apparatus in the second chapter, and the presentation of the picture of the primary processes given in the remaining two chapters.

The chapter headings of this book are listed below: 1. The Natural History of Photosynthesis; 2. The Photosynthetic Apparatus; 3. The Era of Radiation Physics; 4. The Era of Photochemistry.

C. V. R.

Chemical Analysis without H_2S—Using Potassium Trithiocarbonate. By K. N. Johri. (Asia Publishing House, Bombay), 1963. Pp. 107. Price Rs. 9·00.

The book describes the preparation of the reagent K_2CS_3 by the addition of carbon disulphide to an aqueous solution of potassium

hydroxide. It develops in considerable detail the use of this reagent in chemical analysis as a substitute for hydrogen sulphide, which, as is well known, has several undesirable qualities and is definitely toxic. The author has developed the use of potassium trithiocarbonate as a reagent in the laboratories of the Delhi University and his efforts have evoked considerable interest abroad. The book should prove useful in spreading the application of this reagent in the teaching of analytical chemistry.

C. V. R.

Models and Analogies in Science. By Mary B. Hesse. (Sheed and Ward, London and New York), 1963. Pp. 150. Price 15 *sh.*

This book is the fourteenth of the series entitled *Newman History and Philosophy of Science.* The author is Lecturer in the Philosophy of Science at the University of Cambridge. The subject-matter is dealt with in three chapters with the following titles : 1. The Function of Models : A Dialogue ; 2. Material Analogy ; 3. The Logic of Analogy. Suggestions for further readings are also given.

C. V. R.

Veterinary Entomology and Acarology for India. By S. K. Sen and T. Bainbrigge Fletcher. (Indian Council for Agricultural Research, New Delhi), 1962. Pp. iv + 668. Price Rs. 20·00.

Insects, ticks and mites do great damage to domesticated animals by direct annoyance and by conveying or carrying disease, either directly or indirectly. The annual loss of national wealth of India due to these causes is undoubtedly great. A systematic survey of these organisms and of their activities is therefore of great importance. The present treatise is the result of the studies of the subject made over many years by the authors in the course of their official career. Apart from listing the various species, the book also deals with their internal and external anatomy, with insect behaviour, the transmission by them of animal diseases and includes a chapter on general entomological methods. No less than 232 line-drawings and

fifty plates, each containing numerous figures, many of them in colour, illustrate the volume.

C. V. R.

Biology. By J. W. Kimball. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A.), 1965. Pp. 704. Size 24 cm. × 19 cm. Double column. Price $ 8.75.

Intended for beginning students with no particular previous knowledge of the subject, *Biology* by Kimball is an excellent introductory presentation which will help to obtain a broad idea of the subject as a whole. With its numerous illustrations and lucid treatment the book should appeal even to the lay-reader interested in general biology and life sciences.

The systematic presentation includes the following topics : Characteristics of life, variety of life, the complex organization of life, metabolism, responsiveness and co-ordination, chemical bases of life, photosynthesis, Mendel's work, reproduction, evolution, and ecology. Problems are included at the end of each chapter.

A. S. G.

The Indian Ephemeris and Nautical Almanac for 1966. (Published by the Manager of Publications, Civil Lines, Delhi-6, for the Nautical Almanac Unit, Regional Meteorological Centre, Alipore, Calcutta-27). Pp. 462. Price Rs. 14 ; 32 *sh.* 8 *d* ; or $ 5.04.

The present Ephemeris is the ninth issue since its inception in 1957 by the Government of India. It is a matter of gratification to note that the Indian Ephemeris, by incorporating the changes recommended by the International Astronomical Union from time to time, and by keeping its data in uniformity with other recognized world ephemerides, is gaining popularity. One of the objects of preparing the Indian Ephemeris and Nautical Almanac is to provide accurate data concerning the positions of the Sun, Moon and Planets, computed in accordance with the most up-to-date astronomical formulæ. It is hoped that almanac-makers will make increasing use of the data thus provided in the preparation of the indigenous almanacs (Pancangas). A. S. G.

Sir C. V. RAMAN

WE return to the subject of the reproduction of colour dealt with in the preceding chapter for a closer examination of the results achieved by the process most frequently employed for that purpose. As has already been there indicated, this operates on the same principle as that used for producing illustrations in black and white and known as the half-tone process. But instead of one half-tone block, the reproduction of colour is based on the use of four such blocks, the impressions of which are transferred to paper using four differently coloured inks, viz., black, yellow, magenta (also known as process red) and cyan (also known as process blue). The four blocks are individually prepared from four separate negatives obtained by photographing the objects under study through four different and appropriately chosen colour filters. It is of great importance to notice that the ruled screens used in making these photographs are set at different angles, viz., for example, at 45° for the black printer, at 75° for the magenta printer, at 90° for the yellow printer and at 105° for the cyan printer. As the result of these arrangements, the rows of dots of varying sizes which are transferred to the paper by the four printing blocks are orientated differently, as can be seen on examining the final printing through a magnifying lens.

A remarkable consequence of the arrangements described above is that the colours perceived by an observer are the impressions produced on his vision by a mosaic of differently coloured dots grouped around each other in a geometric pattern. These mosaics are visible in the finished picture on examination through a magnifying lens. That a great range of colours are thus successfully pictured is a fact of experience which evidently calls for further study and elucidation.

The reproduction of pictures in colour is a common feature in many publications of a popular nature. It is therefore easy for anyone to have access to a great mass of material illustrating scenes and objects of the most varied nature. A detailed study of such pictures through a magnifier makes it possible to arrive at definite conclusions regarding the manner in which the colours observed are related to the mosaic patterns appearing in the reproductions. Such a study demonstrates that the view commonly expressed regarding the reproduction of colour by the half-tone process, viz., that it is based on the subtractive principle of colour superposition, is completely false.

Comparative study of numerous cases makes it evident that the sensation excited by a mosaic of colour dots is determined by the proportion of the areas in it occupied respectively by the four coloured inks used in the printing and by the unoccupied area, if any, of the white surface of the paper. This conclusion emerges from a study covering the most varied examples of objects portrayed as well as of the colours displayed.

The colour most often represented in pictures is the blue of the sky. Depending on the circumstances, the colour thus depicted varies from a very light to a very deep blue, such variations often appearing in one and the same picture and not infrequently in areas adjacent to each other. In the areas depicting a blue sky, yellow dots do not appear at all and it is also unusual to find any dots of black ink. The colours that we do find in mosaics representing a blue sky are cyan, magenta and white. In the more lightly coloured areas, the proportions of white to cyan is very considerable and of the magenta to cyan is generally small. In the bluer skies, the proportion of white to cyan diminishes and may even become negligible. On the other hand, the areas occupied by magenta are proportionately larger, and numerous cases are to be found in which we have only cyan and magenta, the areas occupied by these being comparable with each other.

Cyan ink printed on white paper exhibits both the blue and the green sectors in the spectrum of the light diffused by it, the yellow and red sectors being weakened and indeed nearly suppressed. On the other hand, magenta suppresses the green and the yellow and exhibits only both the blue and the red sectors in the diffused light. It is not surprising in these circumstances that since yellow is absent, blue is the dominant colour in the sensation excited by a mosaic in which cyan and magenta are both present; both green and red being much weakened are masked by the blue and are not perceived.

Of particular interest in this connection are the pictures of specimens of *lapis lazuli* found in Afghanistan which will be found reproduced

on page 434 of the *Geographical Magazine* for October 1965. Sixteen specimens are shown grouped together, their hues ranging from a light blue to a dark blue approaching violet in colour. The greenish-blue dots of cyan ink can be recognised in the reproductions of all the specimens, even in those which seem to the eye to be dark blue in colour. The spots of magenta ink are also visible, but they are not very conspicuous. It is evident that the black printer has played a highly important role in the representation of the specimens which exhibit darker hues. Indeed, these pictures suggest that a greatly diminished brightness of the mosaics is itself the reason why the blues are perceived as being of darker hues approximating to violet in colour.

The dominant colour of vegetation is green and it figures very prominently in pictures of gardens and parks. The shade of colour varies from a light green in the case of freshly-grown grass to a deep green in the mature leaves of well-grown trees. Cyan and yellow are the prominent features in the areas of mosaic which appear as green in the pictures. The greater the proportion of yellow to the cyan, the lighter is the green colour which is perceived. These results are intelligible, since cyan ink exhibits both blue and green strongly while weakening the yellow and the red. On the other hand, yellow ink extinguishes the blue while the rest of the spectrum is perceived including especially the yellow. In the resulting sensation, therefore, the green is dominant. The more completely the yellow and red are suppressed by the cyan, the deeper would be the green exhibited by the mosaic.

Pictures in colour of well-known personages are very popular. The chief interest in such pictures is, of course, the individual himself, including especially the contours of his face, his complexion, the colour of the eyes and other important details. These features differ widely from individual to individual. Certain general characteristics may, however, be recognised. In a great many cases, magenta and yellow are the principal colours noticeable in the mosaics appearing in the reproduction of the faces. The more sun-tanned the complexion is, the greater is the proportion of the magenta to the yellow. In the darker areas, the yellow is replaced by black, and a sprinkling of cyan is also noticeable. Indeed, the examination of portraits reproduced in colour furnishes a highly instructive demonstration of the role played by the mosaic of colour spots in determining what we perceive in the pictures.

Brightly coloured dresses form an attractive feature in pictures of assemblies or public gatherings. Examination of such pictures is a convenient procedure for ascertaining how the proportion of the inks present in the mosaics determines the perceived colour. Taking, for instance, the brilliantly coloured tartans exhibiting stripes of colour which are a familiar feature in pictures of Scottish assemblies, one can trace the colour composition of each individual stripe as reproduced in the half-tone picture. In the orange-coloured stripes, the mosaic consists of rows of yellow and magenta crossing each other, these occupying approximately equal areas. In the red stripes, we have also a mosaic of magenta and yellow, but the magenta is then preponderant. In the green stripes, we have mosaics of cyan, yellow and black, and in the blue stripes, mosaics of cyan, magenta and white.

The reproduction of floral colours by the half-tone process is a subject in itself. Flowers being the principal adornment in public parks as well as in the gardens attached to private houses, they are favourite subjects for colour photography as also for pictures to illustrate publications dealing with various aspects of town and country life. There is a further reason for the great interest shown in reproducing pictures of flowers. A great industry has grown up devoted to the production and marketing of flowering plants and especially new varieties thereof. Colour plays a highly important role in the selection and popularity of the new varieties, and horticulturists are therefore at great pains to produce literature in which the nuances of colour of their productions are accurately displayed.

As an illustration of the foregoing remarks, we may mention a recently published pocket encyclopædia of roses in which no fewer than 421 varieties of roses have been illustrated in colour, together with their origins and pedigrees and a detailed description of the blooms. The colours of the roses have been classified into nine distinct groups. A systematic examination of all the pictures reproduced in this publication showed that in all except three cases, the colour mosaics showed only three inks, *viz.*, yellow, black and red, besides white areas. The three exceptions were roses which displayed lilac coloured hues, the distinctive colour being evidently due to the presence of cyan as one of the components in the mosaics.

IDENTIFICATION OF THE 1-0 AND 1-2 BANDS OF THE $c\,^3\Sigma^+ \to a\,^3\Pi$ SYSTEM OF BF

S. L. N. G. KRISHNAMACHARI AND MAHAVIR SINGH

Spectroscopy Division, Atomic Energy Establishment, Trombay, 414 A, Cadell Road, Bombay-28

TWO triplet band systems, $b\,^3\Sigma^+ \to a\,^3\Pi$ and $c\,^3\Sigma^+ \to a\,^3\Pi$, are known for the BF molecule.[1,2] The vibrational frequencies for the $a\,^3\Pi$ and $b\,^3\Sigma_+$ states were known while that for the $c\,^3\Sigma^+$ state was unknown so far as no

using BF_3 samples enriched to 20, 54 and 90% ^{10}B. The resulting spectra are shown in Fig. 1 for the $c \to a$ system. The intensity of the band heads due to ^{10}BF increases approximately with increasing ^{10}B content while that
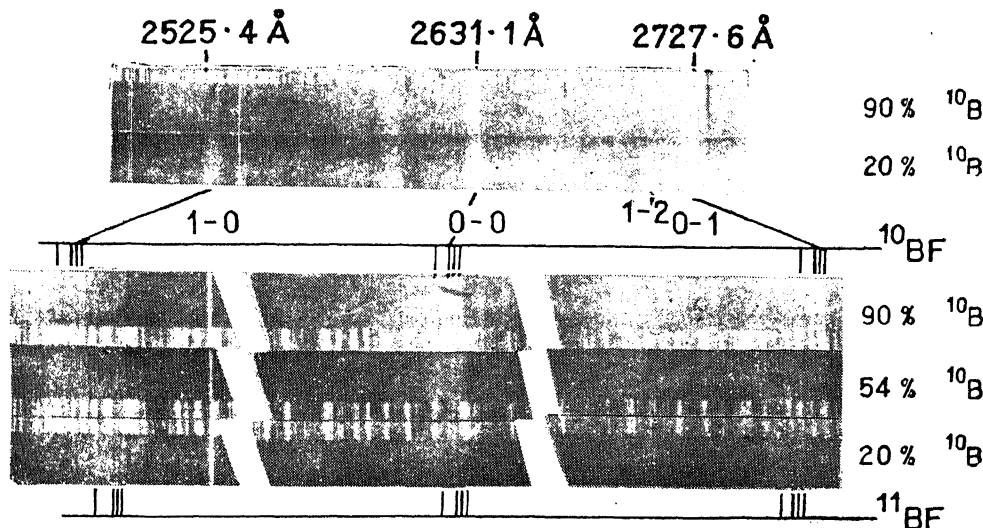
FIG. 1. Part of the $c\,^3\Sigma^+ \to a\,^3\Pi$ system of the BF molecule recorded on Hilger large quartz spectrograph at a dispersion of 2·8 Å/n m. at 2500 Å. The upper and lower sets of spectra are prints from the same negative with different enlargements.

bands involving $v' \geqslant 1$ of this state were observed earlier, and the failure to observe these bands was presumed to be due to predissociation.[3]

During the course of our investigations on the discharges through BF_3 gas, while using a radio-frequency oscillator (3-11 Mc./sec. frequency and 100 watts power) two new bands were observed at 2525 Å and 2707 Å (for ^{10}BF molecule) along with the other known bands of the $c \to a$ and $b \to a$ systems. The new bands could be obtained with good intensity at very low pressures (few microns) of BF_3. These are violet degraded and contain five prominent heads, four of which are strong. They resemble closely the bands of the $c \to a$ system. Further, the bands could be fitted into the $c \to a$ system as the 1-0 and 1-2 bands.

In order to confirm the vibrational assignment of these new bands, spectra were obtained

of ^{11}BF decreases in the same proportion. Table I represents the vibrational scheme for all the observed band heads of the $c \to a$ system of ^{10}BF along with the isotope shifts (average value for the four heads) for the 1-0, 0-0, 0-1, 1-2, 0-2 bands immediately below their respective wave-number values. Calculated shifts are given in parenthesis. The agreement between the calculated and observed shifts confirms the proposed vibrational assignment for the bands.

In the present studies, though the $v' = 1$ level of the upper $c\,^3\Sigma^+$ state is located, it has not been possible to observe further levels of $v' \geqslant 2$. It is noticed that even the bands arising from $v' = 1$ level are comparatively weak and occur at very low pressure of BF_3 in the RF discharge. Predissociation of the upper vibrational levels is believed to be responsible for the above effects.

TABLE I

Deslandres scheme for band heads of c $^3\Sigma^+$ → a $^3\Pi$ *system of* ^{10}BF

v'' v'	0		1		2		3
0	37996·2 P₃	1344·9	36651·3 P₃	1324·5	35326·8 P₃	1304·3	34022·5 P₃
	38003·5 P₂	1344·6	58·9 P₂	1323·6	35·3 P₂	1304·8	30·5 P₂
	12·2 P₁	1344·0	68·2 P₁	1324·3	43·9 P₁	1303·4	40·5 P₁
	33·6 Q	1346·5	87·1 Q	1324·3	62·8 Q	1304·6	58·2 Q
(i.s.)	4·2 (3·6)		36·4 (36·4)		73·9 (75·3)		
	1589·4				1588·9		
	1589·0				1588·6		
	1587·7				1591·0		
	1588·6				1590·1		
1	39585·6 P₃				36915·7 P₃		
	92·5 P₂				23·9 P₂		
	99·9 P₁				34·9 P₁		
	622·2 Q				52·9 Q		
(i.s.)	51·9 (51·0)				27·0 (28·0)		

For calculating the isotope shift, value of $\omega_e X_e$ for c $^3\Sigma^+$ state has been taken as that of a $^3\Pi$ state.

Bands observed for the b → a system of the ^{10}BF molecule are arranged in a Deslandres vibrational scheme shown in Table II. The wave-number values of the band heads. Thus the present data give confirmatory evidence of the vibrational analysis of the b → a system as well.

The vibrational constants derived for the a $^3\Pi$, b $^3\Sigma^+$ and c $^3\Sigma^+$ states for the ^{10}BF molecule are given in Table III and compared against the calculated values.

TABLE II

Deslandres scheme for band heads of b $^3\Sigma^+$ → a $^3\Pi$ *system of* ^{10}BF

v'' v'	0		1	
0	32025·2 P₃	1345·0	30680·2 P₃	
	33·4 P₂	1344·7	88·7 P₂	
	42·6 P₁	1344·8	97·8 P₁	
	63·4 Q	1347·0	30716·4 Q	
(i.s.)	4·2 (4·6)		35·8 (35·5)	
	1632·5			
	1632·1			
	1631·0			
	1630·8			
1	33657·7 P₃			
	65·5 P₂			
	73·6 P₁			
	94·2 Q			
(i.s.)	51·8 (52·5)			
	1584·8			
	1583·6			
	1582·8			
2	35242·5 P₃			
	49·1 P₂			
	56·4 P₁			
(i.s.)	95·5 (97·6)			

TABLE III

Vibrational constants for ^{10}BF *(in* cm.$^{-1}$*)*

State	Derived from present data		Calculated from data of ^{11}BF	
	ω_e	$\omega_e X_e$	ω_e	$\omega_e X_e$
c $^3\Sigma^+$	[1588·7]		[1588·7*]	
b $^3\Sigma^+$	1679·5	24·0	1680·0†	23·7
a $^3\Pi$	1365·4	10·2	1365·1†	9·8

Values given in [   ] are $\triangle$ G$_{\frac{1}{2}}$.

* The ^{11}BF data used here are obtained in the present investigation.

† The ^{11}BF data used here are taken from ref. 3.

isotope shifts from the corresponding ones of ^{11}BF, observed and calculated, are given below

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A BRIEF REVIEW OF THE EXISTING THEORIES OF THE SOUTHWEST MONSOON AND OF THE PROCEEDINGS OF THE SYMPOSIUM ON METEOROLOGICAL RESULTS OF IIOE, 22nd-26th JULY, 1965, BOMBAY

B. N. DESAI

173, Swami Vivekananda Road, Vile Parle (West), Bombay-56

IT has hitherto been considered that the rainfall over India, during the south-west monsoon season June to September, is caused by the arrival over the country of the deflected south-east trades from the southern hemisphere and that the orographic features of the country, i.e., the Western Ghats, the Eastern Ghats, the mountains on the Burma coast, the Assam hills, the Himalayas and mountains in the north-west frontier of the subcontinent play an important role in the distribution and intensity of rainfall (Simpson, 1921). Also on the basis of data of upper air collected over India and the neighbouring countries, the monsoon current is generally found to be 4 to 5 km. deep (*Indian Meteorological Department Climatological Charts*, 1943, 1945).

The above conclusions were arrived at in the absence of upper air observations over the Arabian Sea, the Bay of Bengal and the Indian Ocean. During World War II, upper air observations were taken at Addu Atol close to the equator near Long. 73° E. and they showed that the air was considerably drier there than what was hitherto considered. These observations at the equator were, however, reconciled on the basis that the deflected south-east trades during their movement to the Indian subcontinent would gain moisture sufficiently at all levels as a result of their travel of about 4,000 miles over the sea.

Petterssen (1953) has considered the dynamics of the Indian south-west monsoon. He has stated that while perturbations on the monsoon are quite important from the point of view of its vagaries from year to year with reference to rainfall, one has to consider the creation of vorticity by thermal processes and its balancing by frictional dissipation and export particularly downwind to the Bay of Bengal, for realising the steady state of the monsoon; the resulting large-scale cyclonic system will create and maintain an area of low pressure in the lower levels over the Indian subcontinent. India is to the south of the westerly jet stream as a result of which the vorticity decreases with elevation, but the jet is not a part of the monsoon itself. Further, the mechanical influences of the orographic features of the subcontinent— the Western Ghats, the Eastern Ghats, the Burma and Assam mountains and the Himalayas have to be given due weight, as frictional force will act against the motion.

The bulk of the import of air into India during the south-west monsoon season is across the Western Ghats with ascending motion on the western slope and descending motion on the eastern slope; a small portion enters direct into the Bay south of about Lat. 8° N. Allowing the modifying influence of friction on vorticity, the net result will be a ridge of anticyclonic vorticity over the Ghats with a gradual change to a maximum of cyclonic relative vorticity further to the east and also to the north of the northern shoulder of the Ghats. The Arakan hills to some extent (some of the monsoon current will also pass across them), the Assam mountains and the Himalayas are deflecting the monsoon current to north-west India; the main effect of the deflecting action will be a frictional consumption of vorticity. The topographical features of the subcontinent thus contribute significantly in making the Indian south-west monsoon a self-sustaining system driven by local heat source and balanced by frictional dissipation.

Climatological studies (1943, 1945, 1958) have revealed that during the south-west monsoon period, the seasonal trough of low pressure over the Indo-Gangetic plain is not shallow; its axis is sloping equatorwards with elevation and at 6 km. it runs roughly along Lat. 18° N. over the Peninsula and then south-eastwards towards the Andaman Islands. There is moist westerly air to the south of the trough axis and moist easterly air to its north; a wedge of drier continental air is also present at the western end of the trough. Study of air masses and partitions between them and their inclination with elevation has thus been prevalent to some extent in the forecasting offices of the Indian Meteorological Department. The flow patterns are significantly affected by the topographical features, the influence of the latter extending even upto 500 mb. level in the north as a result of the Himalayas; the migratory systems entering the subcontinent also get modified by the topography.

In view of the influence of the orographic features in the production of weather and

climatological patterns, it has hitherto been the practice to have intensive study during the south-west monsoon season of the conditions at the surface, 900, 850, 700, 600 and 500 mb. particularly, although during the last decade or so study of circulation at levels above 500 mb. is also being made.

Although plenty of information is available for the Indian subcontinent and neighbouring land areas, for the surface and upper air conditions on which the existing ideas of the mechanism of south-west monsoon are based, there has been very inadequate knowledge of the actual conditions over the seas except at the surface. As a result the International Indian Ocean Expedition (IIOE) was organised and very valuable data over the Indian seas have been collected during 1963 and 1964. A preliminary presentation of some of the data was made in a seminar held at Bombay on 1st August 1963 ; a fuller presentation of the data was made during the symposium at Bombay from 22nd-26th July, 1965 by various workers of the International Meteorological Centre at Bombay and by others who took part in the Expedition as also by some workers at Poona and other offices of the Indian Meteorological Department. The results of the IIOE presented by them can be summarised as under :

(*i*) Equator : To the west of Long. 50° E., there is moist unstable layer upto about 900 mb. and presence of an inversion or isothermal layer between about 850 and 800 mb. and of relatively drier unstable layer upto about 600 mb. ; decrease of moisture is rapid above 900 mb.

At Gan (Long. 73° E.) near the equator (basis July mean) there was rather unstable lapse upto about 850 mb. and more stable lapse above upto 500 mb. level, and no inversion or isothermal layer ; moisture continuously decreases with height, but it was more at all levels than at places on the equator west of Long. 50° E.

(*ii*) Arabian Sea west of Long. about 70° E. : Conditions were more or less similar to those at the equator west of Long. 50° E. except for the fact that there is relatively more moisture in the levels upto about 900 mb. in the central Arabian Sea ; the height of base of inversion is about 1 km. off Sind coast and in the west Arabian Sea west of about Long. 60° E.

There is no appreciable change in the moisture content between about Lats. 5° and 20° N. and Longs. 50° and 70° E. between about 900 and 700 mb.

There is practically no convective cloud or middle or high cloud but there is a broken to overcast layer of low stratocumulus. There is practically no rain.

(*iii*) Arabian Sea east of Long. 70° E. and south of Lat. 20° N. : As one approaches coast, the height of the base of inversion is raised and its thickness decreases, the inversion disappearing over Bombay, where there was considerable increase in moisture at all levels when compared with places to the west during active monsoon.

Weather and cloudiness increase towards coast, there being presence of large and towering Cu and Cb clouds above low nimbostratus sheet and precipitation within 200 to 300 miles of the coast, the effect being maximum at and near the Western Ghats.

(*iv*) At Bombay, Minicoy and Gan (all near Long. 73° E.) there was in the mean for July no inversion ; temperature and moisture were 1° to 3° C. and 1 to 3 gm./kg. higher respectively at Bombay than over Minicoy which in turn has temperature about 1° C. higher and moisture 1 to 3 gm./kg. more than at Gan.

(*v*) Of the air masses present, the monsoon air is the coldest at the surface.

(*vi*) There is presence of a trough just to the south of equator between about Long. 58° and 110° E. Westerlies extend upto about 500 mb. near the equator.

(*vii*) Inversions are practically absent over the Bay of Bengal during active monsoon.

(*viii*) There is presence of a jet maximum speed of 25 m./sec. between Long. 53° E. at a height of about 560 metres and Long. 58° E. at a height of about 1,000 metres ; the magnitude of the jet decreases eastwards being only about 15 m./sec. near India.

There is no jet north of Lat. 20° N. and also at Lat. 4° N.

From what has been stated above it is clear that the IIOE expedition results over the Arabian Sea bring out very clearly that during the months June to September, there is *no* homogeneous monsoon current of 4 to 5 km. thickness over the Arabian Sea off the west coast of the Peninsula as hitherto considered ; there is a peculiar air mass stratification—lower moist (upto about 850 mb.) and upper drier unstable air masses with an inversion between the two, there being no convective clouds and rain west of about Long. 70° E. These results would require modification in the existing mechanism of south-west monsoon as hitherto understood by the Indian Meteorologists.

The results of the IIOE expedition have been discussed by the workers referred to earlier in

the papers presented by them at the Bombay seminar in 1963 and symposium in 1965 and they have put forward their views regarding the mechanism of south-west monsoon—little or no rain over west and north Arabian Sea and over Sind and neighbourhood due to subsidence (presence of inversion) over the areas preventing formation of convective clouds and rain and (ii) over the west coast of the Peninsula, particularly in the northern portion and upto Kutch, rain occurs due to a quasi-stationary mid-tropospheric depression which develops, intensifies and dissipates over a period of two to three weeks in the vicinity of Bombay and whose origins are usually obscure. There was no attempt by any worker to modify the hitherto accepted theories of the south-west monsoon in the light of the IIOE results and one actually got an impression that according to them the existing ideas required a radical revision.

It may be mentioned that more than 40 papers were presented in the symposium in the four days and there was little time (in all about a total of four hours) for fruitful discussion of the interpretations put forward. As such the Indian Meteorologists present had no opportunity to present a revised mechanism of the south-west monsoon reconciling the new important facts of observations over the seas during IIOE period. From the interpretations of the results presented during the symposium one cannot help getting an impression that much more attention needs to be paid to (i) the facts of weather and climatology during the south-west monsoon season and (ii) the orographic features of the Indian subcontinent. The reviewer proposes in the light of his experience of over twenty years in day-to-day forecasting of weather to interpret in due course the IIOE results modifying the hitherto accepted mechanism of south-west monsoon only to a small extent in so far as the effect of the Western Ghats is concerned to destroy the inversion and produce a more or less homogeneous air mass in the first 5 km. above the surface over the Peninsula.

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BIOGEOGRAPHY AND ECOLOGY IN ANTARCTICA *

ANTARCTICA has become a gigantic laboratory and research field, thanks to the International Geophysical Year, and it has been recognized so by the Antarctic Treaty signed in 1959 by the twelve nations which participated in the IGY Antarctic expeditions. The treaty guarantees freedom of scientific research in this vast territory for a period of thirty years, and the members have enjoined to use it only for peaceful purposes.

Most of the Antarctic mainland is an ice desert with the thickness of ice varying from 2,000 to 4,000 metres. As part of their programme for the IGY the twelve nations established permanent or semi-permanent bases on the Antarctic continent or on sub-Antarctic islands and collected a vast amount of scientific data in different fields of study. The book under review gives a general survey of what had been done by them in the way of biogeographical and ecological research. The Editors were actively concerned with the international scientific activities in the Antarctic, and with the co-operation of a team of internationally reputed authors they have brought out a volume of great utility which not only sums up the present state of knowledge in the subjects of the title but also points the way to future planned investigations in the Antarctica.

The book is in two main parts. The first part of three chapters gives a detailed description of the different aspects of the environment including the geology and morphology, the climatology and the oceanography of the regions. The second part of fifteen chapters is devoted to the discussion of some of the main plant micro-organisms and animal groups of these regions. The subjects dealt with are Algæ, Lichens, Vascular plants, Crustacea, Mollusca, Copepoda, Bryozoa. There are chapters on Acarology, Land arthropods, Fish fauna and Birds of Antarctica. A long article, in French, is the one on the "Ecology of Antarctic Penguins", which is illustrated by 24 plates. The book concludes with an interesting chapter on Human adaptation to life in Antarctica.

The book is an example of the significant fact that international co-operation can achieve a lot in the way of scientific advancement,

LETTERS TO THE EDITOR

ZEEMAN EFFECT OF NQR LINE OF p-BROMO PHENOL

It is well known that Zeeman effect studies of Nuclear Quadrupole Resonance (NQR) yield information about orientation of molecules and bond characters in solids.[1] The present note reports new results in the Zeeman effect study of Br^{79} in p-bromo phenol. Large single crystals were grown from melt. Pure quadrupole resonance for Br^{79} was reported[2] at the frequency 264·69 Mc./s.[3] at room temperature. The signal was almost as strong as in p-dibromo benzene. Only a single line was obtained while Dean[4] reported two lines for p-chloro phenol. Zeeman effect of the resonance line was investigated using a Helmholtz coil assembly which gives a uniform magnetic field.

The crystal structure of p-bromo phenol is not known except that it is tetragonal bipyramidal.[5] A preliminary optical study showed that the growth axis of the cylindrical crystal was the c-axis. For obtaining a knowledge of the number of field gradients, the cylindrical crystal was cut (1) parallel to the growth axis, (2) perpendicular to the growth axis and (3) in a direction perpendicular to both (1) and (2). Two field gradients were found but the asymmetry parameter was same in both cases. The value of η was calculated to be $0·07 \pm 0·03$ by the least squares method for five different zero splitting loci obtained from different crystals and their cuts, three belonging to one field gradient and two to the other. From a preliminary analysis Dean[4] reported a η value of 0·08 for p-chloro phenol. The bond characters[6] in p-bromo phenol were calculated from the observed η value. These are : single bond character 79·4%, double bond character 2·6%, and ionic character 18%.

The temperature variation of the frequency was also investigated. Two lines[2] were observed at the lower temperature. These were at 269·36 Mc./s. and 267·96 Mc./s. at liquid oxygen temperature merging into one at a temperature –145° C.

We are grateful to Prof. K. R. Rao for his kind interest and to Mr. K. Kameswara Rao for his help in calculations. Our thanks are also due to Dr. C. B. Rao of Geology Department for his help in determining the growth axis of the crystal. One of us (K. V. S. R.) is grate-

ful to the Council of Scientific and Industrial Research for the award of a Fellowship.

Department of Physics,   K. V. S. Rama Rao.
Andhra University,   C. R. K. Murty.
Waltair, September 6, 1965.

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ROTATIONAL ANALYSIS OF FOUR BANDS OF AN ULTRA-VIOLET SYSTEM OF BiO

The ultra-violet absorption spectrum of the BiO molecule as reported by Bridge and Howell[1] (1954) is known to consist of two doublet systems of bands in the regions λ 3860–λ 3130 A and λ 2690–λ 2430 Å. The former system comprises single-headed bands degraded towards the red and has been previously attributed by Bridge and Howell to the transition $\sigma^2 \pi^3 \pi^{*2}$, 1/2, 3/2 $(^2\pi) \rightarrow \sigma^2 \pi^4 \pi^*$, 1/2, 3/2 $(^2\pi)$. The longer wavelength sub-system arises from case (c) 1/2–1/2 transition in which the lower state is the case (c) equivalent of the $^2\pi_{\frac{1}{2}}$ ground state of BiO molecule. This sub-system has been studied in emission for the first time in the first order of a 21 ft. concave grating spectrograph (dispersion 1·25 Å/mm.). The rotational analysis of four bands (0, 1), (0, 2), (0, 3) and (0, 4) has been carried out and the rotational constants have been determined and are given in Table I.

The bands reveal only the presence of two branches P and R indicating a transition of the type $^2\pi_{\frac{1}{2}}$–$^2\pi_{\frac{1}{2}}$ or case (c) 1/2–1/2 as has been assumed previously. Recently Gissane and Barrow[2] determined the rotational constants of the lower and upper states of visible system of BiO $(\nu_e = 14183 \text{ cm.}^{-1})$ whose vibrational analysis has already been given by Scari[3] (1956). They attributed the system to case (c) 1/2–1/2 transition in which the lower 1/2 state is the ground state of the molecule. The value of

TABLE I

Molecular constants in the upper and lower states of BiO molecule

Upper state	Lower state
$B_0' = 0.255_6$ cm.$^{-1}$	$B_e'' = 0.303_0$ cm.$^{-1}$
$a_e' = $ ..	$a_e'' = 0.002_1$ cm.$^{-1}$
$D_0' = 0.31 \times 10^{-6}$ cm.$^{-1}$	$D_e'' = 0.49 \times 10^{-6}$ cm.$^{-1}$
$\beta_e' = $ ..	$\beta_e'' = 0.011 \times 10^{-6}$ cm.$^{-1}$
$r_0' = 2.107 \times 10^{-8}$ cm.	$r_e'' = 1.935 \times 10^{-8}$ cm.
$I_0' = 109.5 \times 10^{-40}$ g. cm.^{2}	$I_e'' = 92.35 \times 10^{-40}$ g. cm.^{2}
	$B_0'' = 0.3019$ cm.$^{-1}$
	$r_0'' = 1.938 \times 10^{-8}$ cm.

B_0'' given by them agrees closely with the value obtained by the authors. The value of r_0'' is determined from the well-known formula

$$r_0 = \frac{4.10610}{\mu_A B_0''} \times 10^{-8} cm ,$$

substituting the value 14.8625 for μ_A for BiO as given by Herzberg.[4] The discrepancy between the values of r_0'' obtained by the authors and by Gissane and Barrow is due to the incorrect value of 15.554 for μ_A used by the latter. No Ω^--type doubling has been observed in any of the four bands. Details will be published shortly.

Spectroscopy Lab.,   Y. K. SARAT CHANDRA BABU.
Dept. of Physics,   P. TIRUVENGANNA RAO.
Andhra University,
Waltair, *August* 21, 1965.

Note added in proof: "After communicating this note we have observed under corrigendum of *Proc. Phys. Soc.*, Vol. 86, Part 3, No. 551, p. 682, that the value of r_0'' was corrected by Gissane and Barrow as $r_0'' = 1.938$ Å, which agrees exactly with the value reported by us."

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CHROMATOGRAPHIC PURIFICATION OF POTASSIUM THIOCARBONATE (PTC) REAGENT FOR ITS USE AS DEVELOPER OF CHROMATOGRAMS

INVESTIGATION on the use of PTC as a developing and eluting agent in column chromatography have revealed its great superiority over other developers commonly used, such as hydrogen sulphide-water or aqueous solutions of ammonium sulphide. In the case of hydrogen sulphide, because of its meagre solubility in water, not only low concentration of cations but also the fast-moving cations are developed with difficulty and with widening of the bands. Ammonium sulphide should be saturated with hydrogen sulphide, otherwise amines of the metal ions (Cu^{2+}, Ag^+, Zn^{2+}, Co^{2+}, Ni^{2+}, Cd^{2+}) are formed whereby their order of adsorption is disturbed; over-saturation causes disturbance in the column packing due to the liberation of bubbles of hydrogen sulphide gas.

Chromatographic studies with PTC as a developing agent have afforded sharp and compact bands on alumina columns. The colours of the bands are characteristic of the metal ions in most of the cases because of the formation of thiocarbonates instead of sulphides. Moreover, as it is possible to obtain aqueous solutions of PTC in any desired concentration there is no limitation on the amount of metal ions. PTC reagent,[1-3] as prepared according to the standardised methods, is capable of long storage without undergoing deterioration in purity. Standardised PTC solution,[4,5] when fed on a washed alumina column, leave a few coloured stains despite washing the column with deionised water. The impurities like silica, lead, iron, arsenic, aluminium and zinc present (in traces) are derived from potassium hydroxide and other materials used for the preparation of PTC either by hydrolytic[1] or by direct[4] method. It has now been possible to get PTC of high purity for chromatographic purposes by passing it through alumina column.

Size of Columns.—The standard column used is made of pyrex glass tubing, 20 cm. in length and 2 cm. in diameter. It is packed uniformly with Brockmann's basic alumina and washed several times with deionized water. PTC solutions of concentration within $0.02-1$ M are passed through the column with a flow rate of 1 ml. per minute. The impurities like silica (grey stain), lead (reddish-black stain) and zinc (yellow stain) and other heavy metals are retained on the column. Iron, aluminium and arsenic form water-soluble thiocarbonate complexes and pass through, but do not cause any interference.

The above packing of column is sufficient for purifying about 100 ml. of molar solution of PTC. The purified PTC is collected in Jena or polythene vessel and subsequently diluted to any desired concentration before use. PTC, obtained thus, if fed on alumina column does not leave any stains and is completely washed down the column with deionized water. With PTC solutions of higher concentration than molar, larger columns are required. Solutions of concentration lower than 0.02 M in PTC

undergo partial deterioration into sulphide while passing through the column at the above rate and hence produce mixed colour effects.

The authors are thankful to Prof. T. R. Seshadri, F.R.S., for his keen interest. One of the authors (K. S.) is also grateful to C.S.I.R., New Delhi, for the award of a Followship.

Department of Chemistry,   K. N. Johri.
University of Delhi,   Kirpal Singh.
Delhi-7, *June* 30, 1965.

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EFFECT OF COMPLEXING AGENTS IN THE CHROMIC ACID OXIDATION OF ALCOHOLS—EVIDENCE FOR INTERMEDIATE VALENCE STATES OF CHROMIUM

It is well known that in the oxidation of alcohols by Cr (VI) oxide, the oxidation of the former to the ketone is a two-electron step while the reduction of the latter involves the removal of three electrons. Obviously this reaction has to proceed *via* an intermediate Chromium species which may be Cr (V), Cr (IV) or even Cr (II). The first step of the reaction has however been shown to be a two-electron step involving the formation of Cr (IV) on the basis of isotopic effects on the oxidation[1] and the existence of an induction factor of two in the presence of added manganous and cerous salts.[2] Several schemes have, however, been put forward to account for the conversion of Cr (IV) to Cr (III).[3,4] The present work is concerned with the characterisation of these intermediate valence states of Chromium, based on the fact that while the free ions are very reactive, they could be considerably stabilised by complexation. 2, 2' dipyridyl and 1, 10 phenanthroline which bears a close relationship to the former in structure, are known to react with Cr (II) and Cr (III) and form complexes of analogous structure.[5-7]

We have now investigated the effect of the addition of these two complexing agents on the oxidation of α-hydroxy acids by Cr (VI) oxide. Our results are summarised in Tables I and II.

It is noted that the addition of even a small quantity of the complexing agent [even as low

TABLE I

Effect of added complexing agents in the oxidation of malic acid by chromic acid

Solvent: 50% Acetic acid		Temp. 45° C.
Complexing agent	Concentration of the complexing agent (in moles)	$k_2 \times 10^{-4}$ litre moles/sec.
2, 2' Dipyridyl	..	8·614
	0·001357	10·967
	0·002855	11·516
	0·005102	15·834
	0·02148	38·811
	0·05226	76·53
o-Phenanthroline	0·002149	12·12
	0·004641	21·13
	0·01007	36·33
	0·01535	50·732

TABLE II

Effect of added complexing agents in the oxidation of lactic acid by chromic acid

Solvent: 50% Acetic acid		Temp. 45° C.
Complexing agent	Concentration of the complexing agent (in moles)	$k_2 \times 10^{-4}$ litre moles/sec.
2, 2' Dipyridyl	..	6·292
	0·005646	11·53
	0·01022	15·68
	0·02203	32·91
o-Phenanthroline	0·002936	11·10
	0·004399	14·64
	0·01035	28·58
	0·02035	51·79
Pyridine	0·007469	5·343
	0·01096	5·372
	0·01472	6·102
	0·02535	5·872

as ·0015 M. as against the Cr (VI) concentration of ·006 M.] gives a rate enhancement. That this rate benefit is not due to any base catalysis is shown by the failure of added pyridine to have any effect on the rate of oxidation. The higher rate benefit in the case of o-phenanthroline is due to the fact that this reagent while resembling 2, 2' dipyridyl in its co-ordinating ability, forms somewhat more stable complexes. In either case the rate enhancement is directly proportional to the concentration of the complexing agent.

Our results indicate that Cr (II) is a very likely intermediate in the course of the reduction of Cr (VI) to Cr (III). For, it is known that although Cr (II) is a powerful reducing agent, some Cr (II) complexes most stable towards oxidation contain dipyridyl, hydrazine or o-phenanthroline as complexing agents,[8]

Preliminary colorimetric estimations in these laboratories, with freshly prepared chromous acetate solutions, also show that Cr(II) is a likely intermediate in the reduction of hexavalent chromium to the trivalent state.

Our thanks are due to the C.S.I.R., New Delhi, for the award of a Junior Research Fellowship to one of us (S. S.).

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Vivekananda College, S. SUNDARAM.
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INVESTIGATION ON THE HAEMOLYMPH OF THE SOUTH INDIAN SCORPION, *HETEROMETRUS SCABER*

BRICTEUX *et al.*[1] have reported that the major component of the haemolymph of Australian scorpion, *Androctonus australis* is trehalose. The present note reports results of study on the haemolymph of the South Indian scorpion *Heterometrus scaber* with respect to the nature of the carbohydrates, proteins and amino-acid components.

Sugars were detected and estimated in the haemolymph by paper chromatography using *n*-butanol : acetic acid : water (4 : 1 : 4) for the first run and saturated phenol for the second run. The haemolymph was deproteinised with 70% alcohol at 75° and the alcohol solution after deionisation with a mixed resin (Dowex 1 and 50), was evaporated and the sugars dissolved in water and used for running the chromatograms. Trevelyan's method[2] was used for the detection of the sugars. Only glucose and trehalose were detected and confirmed in the haemolymph, glucose being the main component while trehalose was present only in traces. No other sugar was detected.

Quantitative estimations of glucose and trehalose in the haemolymph were carried out by eluting the sugars from the paper chromatograms with water and analysing with anthrone reagent. Estimation by chemical method was also carried out according to the method of Asatoor and King[3] for glucose and that of Wyatt and Kalf[4] for trehalose. The values, obtained for glucose and trehalose in different lots obtained from different groups of scorpions, varied from 15·20 to 41·80 mg./100 c.c. in the case of glucose and 4·17 to 11·12 mg./100 c.c. in the case of trehalose. These results differ from those reported by Bricteux *et al.* for *Androctonus australis* where trehalose is the major component.

The free amino-acid pattern of the haemolymph was studied by deproteinising the haemolymph with 85% alcohol and extracting the aqueous alcoholic solution with 3 volumes of chloroform. The aqueous layer after concentration in vacuum was used. Circular paper chromatography using *n*-butanol : acetic acid : water (40 : 10 : 50) was carried out. 0·1% Ninhydrin in acetone was used for locating the amino-acids. The following amino-acids were detected : Glycine (+++), glutamic acid (++), aspartic acid (++), alanine (++++), taurine (+), serine (+), histidine (+), isoleucine (+), tyrosine (+), phenyl alanine (+), arginine (+) and cysteine (+).

Paper electrophoresis for proteins of the haemolymph was carried out using 0·1 M veronal acetate buffer (pH 8·6). The proteins were stained with bromophenol blue and compared with the pattern obtained with human serum. The protein pattern of the haemolymph differed from that of human serum in that, there was very little or no fraction in the haemolymph corresponding to the γ-globulin of human serum. The fraction of haemolymph corresponding to the albumin of the human serum formed the major component, being present to the extent of 75–80% of the whole protein, while the globulin fractions (corresponding to the α_1, α_2 and β-globulins) were present only in small amounts 2–3%, 3–5% and 5–10% respectively.

Division of Biochemistry,   P. A. KURUP.
Kerala University,
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ICE-CRYSTAL MARKINGS IN THE SILICIFIED SHALE FORMATION, KAIMUR GROUP, VINDHYAN SYSTEM *

IT has been accepted for a long time that the climate during the Vindhyan period was arid to semi-arid.[4] This appears to be true for some parts of this period, but workers like Dubey and Chaudhary,[5] Law,[6] Ahmad[1,2] and Mathur[9] are among those who have suggested glaciation and cold climate at certain times during the long history of Vindhyan sedimentation. Further evidence of a cold climate in the Vindhyans has come to light with the discovery of some peculiar markings in the beds of the Silicified Shale formation (Kaimur Group) in the Churk-Markundi area, Mirzapur District, U.P., which appear to possess all the characters of impressions of ice-crystals (Fig. 1). It is thus seen that the evidence is
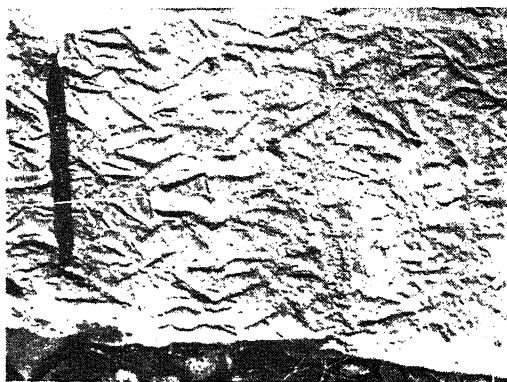
FIG. 1. Ice crystal markings on a slab of sandstone in the Silicified Shale formation, Kaimur Group Vindhyan System.

accumulating for a cold climate during several stages of the Vindhyan sedimentation.

The ice crystals made depressions on the surface of the mud and wet sand on which they were formed. In due course the ice melted, and the sediment hardened, preserving the impressions of the original ice crystals. The stratum deposited above preserved their casts on its undersurface. Both the negative and positive markings are now preserved on the sandy and silty beds in the Silicified Shales. Beautiful specimens of sandstone slabs having ridge-like casts on one surface are often picked up in the field. The negative originals on softer sediment were possibly destroyed by weathering, and are not so frequently seen. Some slabs when split reveal perfectly preserved original depressions and their ridge-like casts.

These markings are rarely longer than 6 cm., wider than 5 mm., or higher or deeper than 5 mm.

Superficially one may be misled to consider these structures as formed by desiccation or synæresis, but the forms produced by these processes are entirely different from those described. The ice-crystal impressions possess distinctive characters. They make shallow linear depressions with open mouths and are only a few centimetres long. They are not oriented in a definite pattern, but are randomly arranged; they may occur individually or in irregular bunches or radiating from a point. They are generally straight, or only slightly curved; they are generally acicular in shape, but some may look like incomplete mud cracks with pointed ends. The ice-crystal impressions formed on clays and silts are fine and needle-shaped, while those on fine sands are wider and less well-defined. They have V-shaped cross-sections with mouths and sides roughly equal. They are often deformed due to compaction and in ancient sediments may present a flattened appearance with U-shaped cross-sections.

While mud cracks and synæresis cracks can form only in sediments of silt and clay sizes, ice-crystal clefts can also be produced in sand, as demonstrated by Allan.[3]

Ice-crystal are formed under favourable conditions from the films of water covering the mud or from the water present in the upper few millimetres of the mud.[10] These crystals produce characteristic curved and rectilinear clefts on the surface of the mud. When the mud dries up later, the clefts may be distorted. The present structures are identical with the ice-crystal markings experimentally produced in the laboratory by Allan.[3] The most distinct markings are produced in sediments finer than the very fine sand size and when the sand is fully saturated. The markings are progressively less distinct as the grain size becomes coarser but may still be clearly recognisable in medium sands.

The presence of the ice-crystal impressions in the Silicified Shales suggests that the temperature at that time was cold enough to cause freezing of water. The climate was probably temperate with severe winters. The sediments on the wide banks along rivers, lake shores and deltas would be suitable for the formation of these crystals.

The author is grateful to Prof. F. Ahmad, Head of the Department of Geology, Aligarh

Muslim University, for confirming his observations and for stimulating discussions in the field.

Northern Region,   S. M. MATHUR.
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A NEW RECORD OF FRESHWATER MEDUSA FROM INDIA

ANNANDALE[1] was first to record from India the freshwater medusa and further describe the same as *Limnocnida indica* Annandale.[2] Subsequently, its widespread occurrence in the riverine system flowing Eastwards from Maharashtra has been reported.[4] To this may be added, the sporadic and brief records of the medusæ from notably the southern part of this country and from a river system which flows westerly into the Arabian Sea.[3,5,10] The information given by these later authors is rather fragmentary. Darling,[3] for example, is silent regarding the specific identity of the medusa she dealt with; though Jones[5] appears to presume that it was *L. indica* Annandale. While the extent to which, in comparison, the similar *Craspedacusta* has been studied, field observations and laboratory studies on *Limnocnida* are surprisingly few.[7] It is evident from the fine ecological notes provided earlier[4] that the medusæ almost invariably appear in the summer months (February to May) and the advent of monsoon rains coincides with their total disappearance from field. It was with a mild surprise, therefore, that one of us (M. V. J.) noticed a small group of medusæ in an experimental aquarium tank of this department and that too in the middle of August 1962. In all about twenty specimens appeared successively within a duration of about two weeks from 18th August 1962. The specimens disappeared from the tank with a dramatic suddenness. Further examination of

this material revealed that the medusæ were new to this subcontinent and the present note is concerned with this. The following description is based on observations on live specimens some of which have been preserved.
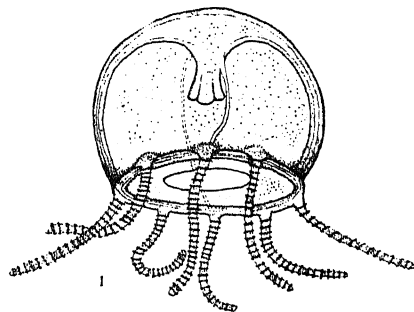

FIG. 1. Lateral and slightly tilted view of the medusa drawn at 36 hours stage (Camera lucida drawing), × 330
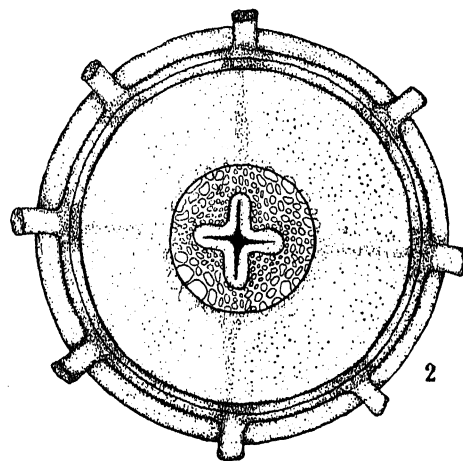

FIG. 2. Camera lucida diagram of the 36 hours' old medusa viewed from the oral side; tentacles not shown, × 330.

Craspedacusta sowerbyi LANKESTER

The bell-shaped umbrella is 0·3 mm. in height and 0·4 mm. in diameter with an appearance of a rather slightly flattened hemisphere. But it is not as flat as in *Limnocnida* being nearly as wide as in height. Manubrium is rather elongate, nearly half the size of its bell, and distinctly quadrate in character. Feebly developed lips form a cruciform mouth. Stomach is spacious although narrowing towards the distal region. There are four unbranched radial canals ending in a narrower ring canal. There are four tentacles adjacent to each radial canal with an additional four alternating with them. The cylindrical tentacles are solid and each 0·2 mm. in length. All are of the same size

and of equal width throughout. Nematocysts are arranged in distinct rings on the tentacles giving a slightly beaded appearance to them. Gonads have not as yet been noticed but slight thickenings observed under phase contrast microscope, in the vicinity of radial canals of some specimens is also suggestive. Velum encloses the statocysts. The movements of the medusæ are characterised by jerky dances in a zig-zag fashion.

Two specimens will be deposited in the Zoological Survey of India, Calcutta-12, India.

The specimens do not agree well at all with either the available descriptions or the actual specimens of the corresponding developmental stage of *Limnocnida indica* Annandale. The possibility that the specimens might belong to the species *Mœrisia gangetica* Kramp[6] was also explored. Recently, one of us (G. T. T.) has compared the specimens under reference with a solitary specimen of *Mœrisia gangetica* Kramp in the collection of Zoological Survey of India, Calcutta. Quite apart from some of the obvious morphological differences between the two forms. *M. gangetica* is an estuarine species with all its near relatives either lacustrine, marine or pelagic. Moreover, it is significant that *Craspedacusta* has been reported so frequently as naturally occurring in the aquarium tanks from many parts of the world.[7] The close resemblance of these specimens to the descriptions and figures given by Potts[8] and Payne[9] is also meaningful. Their sporadic and unpredictable occurrence in the midst of the rainy months lends additional support to consider them for the present as *Craspedacusta sowerbyi* Lankester. How the medusæ first appeared in the aquarium tank will remain a matter of speculation until further projected studies are carried out. Attempts are being made to collect the adults from the source of the aquarium water to provide full details to be published elsewhere.

We are deeply indebted to Dr. P. L. Kramp, Zoological Museum, Copenhagen, for examining the specimens and for suggestions. We are obliged to the Director, Zoological Survey of India, Calcutta, for enabling one of us (G. T. T.) to compare the specimens with the medusæ collection from India. We are also grateful to the authorities of the University of Poona for facilities and to Prof. (Dr.) L. Mulherkar for encouragement.

Department of Zoology,   M. V. Joshi.
University of Poona,   G. T. Tonapi.
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Note.—The remaining references are to be found in these citations.

OCCURRENCE OF *ZIZYPHUS* IN THE LOWER SIWALIKS NEAR JAWALAMUKHI

THERE is an exposure of Lower Siwalik beds about 12 Kilometres north-west of Jawalamukhi, District Kangra, Punjab, from where a large number of leaf impressions have been collected by Dr. Ramesh Dayal and the author. These impressions are borne mostly on fine-grained sandstone and sometimes also on shale.

One of the impressions (Fig. 1) is about 7·5 cm. in length and 4 cm. in width, slightly

FIG I. *Zizyphus* from Siwaliks.

inequilateral, and with a subcordate, triplinerved base. In the general look and details of venation it bears a very close resemblance with the leaves of *Zizyphus*. Mostly the leaves of this

genus are small but bigger leaves, comparable in size with the fossil impression, are met with in three species, *viz.*, (1) *Z. rugosa* Lamk., *Z. incurva* Roxb., and (3) *Z. xylopyrus* Willd. It is, thus, fairly apparent that the fossil leaf belonged to a species of *Zizyphus* allied to the three species mentioned above.

The final identification and complete description of the fossil will be published after a detailed comparison has been carried out with the living species of this genus.

Birbal Sahni Inst. of   RAJENDRA N. LAKHANPAL.
Palæobotany,
Lucknow, *August* 12, 1965.

CRICONEMOIDES GEORGII N.SP. (NEMATODA : CRICONEMATIDAE) FROM INDIA

A SINGLE female specimen recovered from the Delhi Water Works 'A' was sent to us for identification. A study of this worm revealed it to be an undescribed species of the genus *Criconemoides* Taylor, 1936, for which the name *C. georgii* n. sp., is proposed.

Criconemoides georgii N. SP.
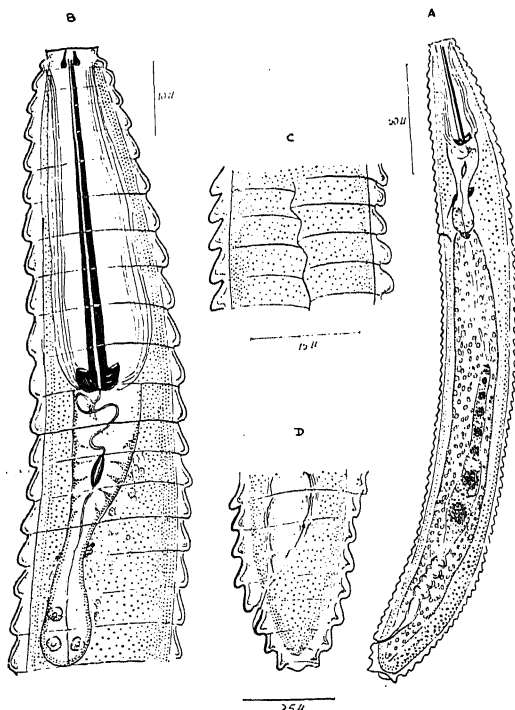
FIG. 1. A–D. *Criconemoides georgii* n.sp. A. Entire female, lateral view. B. Female, neck region. C. Female, lateral field. D. Female, caudal region.

Measurement.—Female (Holotype): Length $= 0.277$ mm.; $a = 7.9$; $b = 3.3$; $c = ?$; $V = 94.5$.

Description.—The eel-worm assumes an almost straight shape on death. Body thick, fusiform, cylindrical, bluntly rounded at either ends. Body cuticle thick, dark brownish in colour, interrupted by 66 coarse body annules. Head continuous with the body with two annules, the first measuring about 7μ, while the second was 9μ. The first annule is distinctive from rest of body annules by having slightly anteriorly directed margins. Body annules anastamosing laterally in a zigzag fashion.

Buccal spear strongly developed, 45μ long with a 31μ long tip, extending up to 12 body annules. Oesophagus Criconematoid, extending up to 20 body annules with a procorpus amalgamated distally with metacorpus to form a swelling 19μ by 9μ in size with a cuticularised valve; isthmus short, posteriorly expanding into basal œsophageal bulb containing the three œsophageal gland nuclei. Opening of dorsal œsophageal gland about 7μ posterior to spear base. Excretory pore 19 annules from anterior end of body; œsophago-intestinal junction well-marked with a conoid-rounded valve. Intestine packed with food granules of varying sizes.

Vulva a transverse slit at the 3rd body annule from posterior end of body. Ovary single, anteriorly outstretched; uterus thick-walled and muscular; spermatheca absent.

Rectum not distinct; anus obscure. Tail bluntly rounded.

Holotype.—Female, deposited in the Nematological collection, I.A.R.I., New Delhi.

Type Habitat and Locality.—Delhi Water Works 'A' in Delhi.

Diagnosis and Relationship.—*Criconemoides georgii* n. sp. comes close to *C. citri* Steiner, 1949, and *C. sphærocephalum* Taylor, 1936. From *C. citri* the present species differs in the lesser extension of spear (spear extending up to 21 annules in *C. citri*), shorter spear and the location of vulva from posterior end of body (vulva on 5th annule in *C. citri*). It can also be separated from *C. sphærocephalum* by the lesser extension of spear, lesser number of body annules and the location of vulva from posterior end of body.

The authors are thankful to Dr. S. Pradhan for providing necessary facilities.

Division of Entomology,   S. K. PRASAD.
Indian Agricultural Research   E. KHAN.
  Institute, New Delhi-12,   V. K. MATHUR.
June 9, 1965.

* Named after Dr. M. G. George of Central Public Health and Eng., Alfred Road, Delhi-6, for placing the material at our disposal .

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OCCURRENCE OF *CURVULARIA TRIFOLII* (KAUFF.) BOED. ON KHAS— *VETIVERIA ZIZANIOIDES* STAPF.

AMONGST the plants being handled at the CIMPO Experimental Farms is *Vetiveria zizanioides* Stapf. whose roots on distillation provide the well-known oil of commerce called "Khas". During February 1965 in our Kodi Farm, a leaf-spot disease was observed on *V. zizanioides*. Tan to dark spots, oval in shape, appeared which later turned black while the rest of the affected leaves became pale yellow. A species of *Curvularia* was isolated from the infected spots and the morphological characters of the fungus on potato dextrose agar are as follows :

Mycelium septate, branched, subhyaline to dark brown, $2 \cdot 5 - 3 \cdot 5 \mu$ wide. Conidiophores simple, brown, paler towards the tip, $3 \cdot 5 - 4 \cdot 5 \mu$ broad, upto 310μ in length, geniculated. Conidia boat-shaped, sometimes straight, usually 3-septate. sometimes 2–4 also ; slightly constricted at the septa : the second or mostly the third cell is larger, broader and darker than the other cells : the apical cell hyaline with obtuse tip, the basal cell crucible form, subhyaline with a distinct protruding hilum, measuring $26 \cdot 4$ $(-38) \times 12$ $(-16) \mu$.

Subramanian (1953) described and illustrated some Indian species of *Curvularia* mostly on the lines adopted by Groves and Skolko (1945). He concluded that spore size is not a decisive character in differentiating the species. While he has recorded C. *lunata* (Wakker) Boed. and C. *trifolii* (Kauff.) Boed. from grass culms, there is so far no record of any *Curvularia* species on *Vetiveria*. Subramanian's identification of C. *lunata* and C. *trifolii* has since been questioned by Parmelee (1956). After a detailed study of *Curvularia* on Gladiolus. Luttrell (1956) and Parmelee (*loc. cit.*) came to the conclusion that C. *lunata* and C. *trifolii* are identical in all morphological characters except that the latter has a protruding hilum. Parmelee has even pointed out that Boedijn (1933) did not mention the character of the hilum in C. *trifolii* (Kauff.)

Boedijn. According to Boedijn (1953), only one species of *Curvularia*, viz., C. *andropogonis* (Zimmermann) Boed., bears a protruding hilum but it has now been established that C. *trifolii* also has a protruding hilum (Parmelee, 1956). The fungus collected and described in this note agrees with *Curvularia trifolii* (Kauff.) Boedijn and not with *Curvularia lunata* (Wakker) Boedijn. To the best of our knowledge this is the first record of C. *trifolii* on *Vetiveria zizanioides* Stapf.
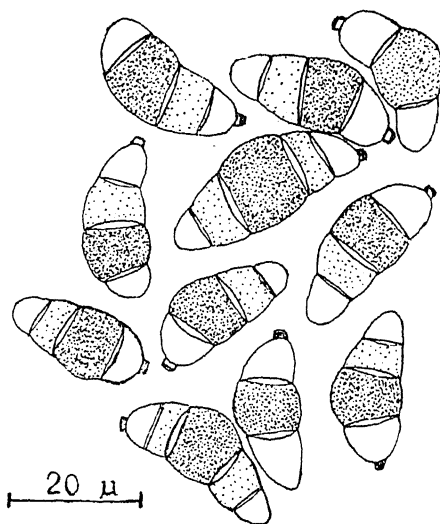

FIG. 1. Conidiospores of *Curvularia trifolii* (Kauff.) Boed.

Thanks are due to Dr. M. N. Ramaswamy for his interest and to Dr. Padmabai Pushpanadan and Prof. M. Nagraj, Botany Department, Central College, for providing laboratory facilities.

Central Indian Medicinal   M. SARWAR.
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Bangalore-11, *June* 11, 1965.

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SECONDARY SPORIDIA IN *HEMILEIA VASTATRIX*

DURING the dry period from January to March profuse production of teliospores were observed on *Coffea arabica*, C. *canephora* and C. *excelsa* growing at Central Coffee Research Institute. The spores were noticed to have germinated

in situ. Cytological studies on the germinating teliospores are being carried out and a detailed account will be published elsewhere. In the present note the formation of secondary sporidia in *Hemileia vastatrix* recorded during the course of study is reported.

The teliospores which arise in the uredosori amidst the uredospores are binucleate (Fig. 1).

Prior to germination karyogamy occurs in the teliospore (Fig. 2). Meiosis starts in the teliospore and with the germination of the spore the entire cell contents along with the division nucleus migrate into the promycelium. A septum may be formed at the base of the promycelium. At metaphase I the chromosomes clump together and orient themselves near

FIGS. 1-20. Fig. 1. A sorus with binucleate uredospores and teliospores. Fig. 2. Teliospore with fusion nucleus. Figs. 3-6. Promycelia with metaphase I, anaphase I, telophase I and late anaphase II nuclei. Fig. 7. Four-celled promycelium. Fig. 8. Three celled promycelium. Fig. 9. Promycelium with four sporidia. Fig. 10. Promycelium with three sporidia. Note a sporidium with two nuclei indicated by an arrow. Figs. 11-12. Germinating sporidia with persistent uninucleate and binucleate condition Figs. 13-20. Development of secondary sporidia. Fig. 16. Nuclear migration to the secondary sporidium. Fig. 18. Uninucleate secondary sporidium with a septum. Fig. 20. Binucleate secondary sporidium with a septum. All except Figs. 1, 2 and 10, × 500.

about the middle part of the promycelium (Fig. 3). At anaphase I a septum is formed after the two groups of chromosomal complements have moved and at metaphase II the two nuclei divide further followed by formation of septa (Figs. 4-6). Thus a four-nucleate promycelium is formed either with four or three septa (Figs. 7, 8). Following the formation of four-celled promycelium four sterigmata are formed and at the tip of each, a single sporidium develops (Fig. 9). Each sporidium gets a daughter nucleus and these nuclei may undergo another division when the sporidium becomes binucleate (Fig. 10).

Both uninucleate and binucleate sporidia are seen in abundance and persistence of both the conditions are observed even after germination (Figs. 11, 12). Apart from the normal germination of the sporidia frequent cases of formation of secondary sporidia are noticed. The sporidium puts forth a germ tube, on the tip of which a spore is formed (Figs. 13-15). The entire cell contents in the primary spore migrate into the secondary one and rarely a septum is formed (Figs. 16-20). The secondary sporidia are usually smaller in size than the primary ones. They are either uninucleate or binucleate depending on the number of nuclei in the primary sporidia. Both types of spores are seen frequently produced under natural conditions. The significance of these secondary sporidia in *Hemileia vastatrix* is unknown.

We thank Sri. R. L. Narasimhaswamy, Botanist, and Dr. N. G. Chokkanna, Director of Research, for their interest in the work and Dr. K. S. Gopalakrishnan, Chief Mycologist, Hindustan Antibiotics, Pimpri, for going through the manuscript.

Division of Botany,   C. C. CHINNAPPA.
Central Coffee Res. Inst.,   M. S. SREENIVASAN.
Coffee Res. Station P.O.,
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OCCURRENCE OF B-CHROMOSOMES IN THE GENUS *CLEMATIS*

A NUMBER of plant and animal species have been reported to contain chromosomes additional to their normal complements.[1] These extra chromosomes. which presumably exert no significant influence on the external morphological features. are variously called B-chromosomes. accessory chromosomes or supernumerary chromosomes. B-chromosomes are of different kinds, some being heteropycnotic while others are not. In some plant species supernumerary chromosomes are found in almost all tissues, whereas in others they are seen only in meiocytes. Usually, supernumerary chromosomes are smaller than the smallest chromosomes of the complement. However, there are some exceptions to this, as in *Sorghum purpureosericeum*[2] and *Clarkia*,[3] where the supernumeraries are as large as normal chromosomes.

The present note is a preliminary report on the occurrence of B-chromosomes in the genus *Clematis*, not previously recorded, so far as the author is aware. However, the occurrence of B-chromosomes in other genera of Ranunculaceæ has been reported, as for example in *ficaria*[4] and others.

The genus comprises some 230 species, of which several shrubs and climbers are of horticultural interest. Eleven species of *Clematis* growing in the garden of the Department of Botany, University of Exeter, were subjected to cytological scrutiny. Somatic metaphase chromosomes were examined from leaf-tips fixed in 3 parts of alcohol and 1 part of propionic acid, the latter having been previously saturated with ferric acetate. After about 24 hours the fixed leaf-tips were hydrolysed in 9 parts of 0·75% acetocarmine and 1 part of normal HCl by heating over a flame in a watch-glass. Later they were cooled and washed in pure acetocarmine.

Of eleven species examined cytologically, one was found to be tetraploid and the other ten diploid with a basic chromosome number of 8. In all the diploid species, the haploid complement was found to consist of 5 chromosomes with median or submedian primary constrictions and 3 with subterminal primary constrictions, one of these being satellited. Similar observations have been made in several other species of *Clematis*.[7] However, 2 diploid species, *C. orientalis* and *C. hatherliensis* (*C. orientalis* × *C. tangutica*) (unpublished) were found to contain 0-2 B-chromosomes in addition to the normal diploid complement of 16. Ten plants in *C. orientalis* were examined. Of these, 1 plant was found to contain 2 B-chromosomes (Fig. 1), 3 plants were found to contain 1 B-chromosome (Fig. 2) and the others none. In *C. hatherliensis*, of 10 plants examined it was found that only one plant had 2 B-chromosomes (Fig. 3), 4 plants had 1 B-chromosome (Fig. 4) and the rest possessed none.

B-chromosomes that have been seen in this genus have been distinctly heterochromatic and smaller than the smallest chromosome of the normal complement. Although their centric or acentric nature could not be seen very clearly, their regular behaviour during cell division indicated that they are probably centric.

FIGS. 1–4. Figs. 1–2. Somatic metaphase chromosomes in *C. orientalis*. Fig. 1. Showing 2 B-chromosomes and Fig. 2. 1 B-chromosome. Figs. 3–4 Somatic metaphase chromosomes in *C. hatherliensis* Fig 3. Showing 2 B-chromosomes and Fig. 4 1 B-chromosome.

During interkinesis B-chromosomes could be seen as darkly staining heterochromatic bodies, their number depending upon the number of B-chromosomes present in the nucleus. At metaphase and anaphase B-chromosomes, like any other chromosomes of the normal complement, showed mostly normal behaviour; they were found to lie on the equatorial plate, and later on to divide and move to the poles regularly. However, very rarely abnormalities such as lagging were observed, as well as inclusion of both the daughter chromatids of the divided B-chromosome in the chromosome complement at one of the poles.

The importance of B-chromosomes in the adaptive mechanism of the plants has been discussed in *Poa alpina*,[8] *Phleum phleoides*[9] and several others. It has been reported in *Clarkia*[3] that the highest frequencies of supernumerary chromosomes are found in ecologically marginal populations which would allow the species to tolerate the extremes of various environmental factors. In view of the great adaptive quality of the plants possessing

B-chromosomes, the detailed survey of these chromosomes in this taxon is under way.

Leverhulme Visiting   K. G. SHAMBULINGAPPA.
  Research Fellow,
Department of Botany,
University of Exeter,
Exeter, U.K., *June* 17, 1965.

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DEVELOPMENT OF THE EMBRYO-SAC, AND EMBRYOGENY IN *CUSCUTA LUPULIFORMIS*

WHILE investigating certain American and European species of *Cuscuta*, some interesting embryological features were noted in *C. lupuliformis* Krock. which are briefly presented in this report.

Allium type of embryo-sac is characteristic of a number of families of the angiosperms while in some others its occurrence is of a rather sporadic nature.[3] Species of *Cuscuta* show a monosporic embryo-sac of the *Polygonum* type[5] except *C. reflexa*.[1] Since it was the only exception, a reinvestigation was suggested.[4] It now stands confirmed that the embryo-sac development in *C. reflexa* is really of the bisporic *Allium* type.[2] It is, therefore, interesting, to find this type of embryo-sac in a yet another species of *Cuscuta*, namely, *C. lupuliformis*.

The megaspore mother cell divides to form a dyad of two cells of which the lower one enlarges (Fig. 1) and its nucleus divides to form a two nucleate embryo-sac (Figs. 2, 3). The upper smaller dyad cell is gradually absorbed by the developing dyad cell (Figs. 2, 3). By two further divisions, the binucleate embryo-sac becomes eight-nucleate which is organised in the usual way (Fig. 4). The antipodal cells are ephemeral and they degenerate by the time the embryo-sac matures (Fig. 5). The egg enlarges and it becomes a
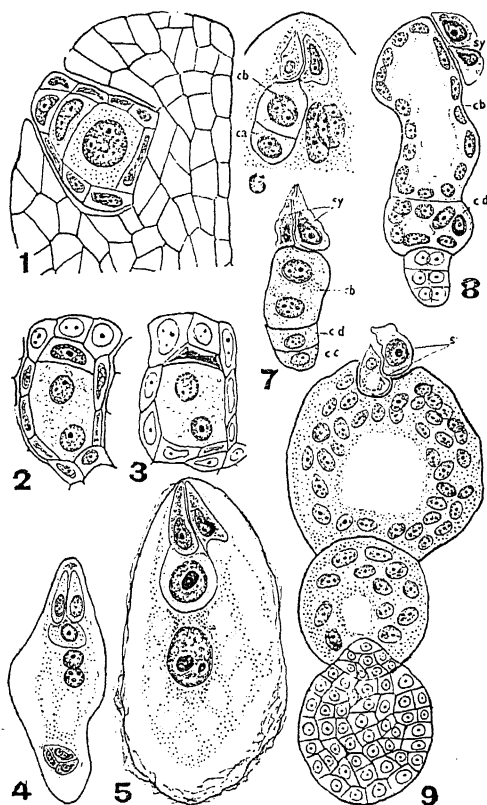
prominent cell of the embryo-sac. A large secondary nucleus results by the fusion of the two polar nuclei (Figs. 4, 5). The pear-shaped

FIGS. 1-9. *Cuscuta lupuliformis.* Fig. 1. L.S. ovule, dyad cells, nucellus, × 360 Fig. 2. Same, binucleate embryo sac, × 360. Fig 3. Same, degenerated dyad cell, binucleate embryo-sac, × 360. Fig. 4. Eight-nucleate embryo-sac, × 267. Fig. 5. Mature embryo-sac × 267. Fig. 6. A portion of the embryo-sac, two celled proembryo, two endosperm nuclei, synergids, × 267. Fig. 7. Three-celled proembryo, basal cell binuculate, synergids, × 267. Fig. 8. Young embryo, two coenocytic suspensor cells, synergids, × 267. Fig. 9. Globular embryo, two rounded coenocytic suspensor cells, persistent synergids partially enclosed in upper suspensor cell, × 167 (Sy = Synergids).

persistent synergids are often without basal vacuoles and filiform apparatus (Fig. 4). They become haustorial and remain in intimate contact with the embryo during the course of its development (Figs. 6-9).

Division of the primary endosperm nucleus and the zygote are almost simultaneous ; the endosperm is of the nuclear type (Fig. 6).

The embryo of *Cuscuta reflexa* is characterised by the presence of haustorial and coenocytic suspensor cells.[2] Interestingly enough, this feature is also shared by *C. lupuliformis* (Figs. 8, 9).

The first division of the zygote is transverse resulting in a basal cell cb and a terminal cell ca (Fig. 6). The former enlarges to develop in a large vacuolated coenocytic haustorial suspensor cell (Figs. 7-9) while the latter divides transversely into two cells which may be designated from below upward as cc and cd (Fig. 7). The latter also enlarges to form another coenocytic suspensor cell (Figs. 8, 9). By further divisions the cell cc develops into the embryo proper (Figs. 7-9). The upper end of the embryonal mass protrudes as a hump into the adjacent coenocytic suspensor cell (Fig. 9).

Development of the embryo-sac and the embryo in *Cuscuta lupuliformis* closely resembles with that of *C. reflexa.*[2] This strengthens their close relationship and placement in the subgenus *Monogynella.*

I am grateful to the Director, University Botanical Garden, Copenhagen, for the material.

University of Rajasthan, B. TIAGI.
Jaipur, *June* 21, 1965.

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REVIEWS AND NOTICES OF BOOKS

Evolution of Mathematical Thought. By Meschkowski. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1965. Pp. 157. Price $ 6.55.

Originally published in German under the title *Wandlungen des mathematischen Denkens*, this book has grown out of a series of lectures meant for a wide circle of interest. The book has been translated by Jane H. Gayl. It is not only for the mathematician who needs to have a general view into the abundance of problems posed by research in the foundations of mathematics, but also for the student or layman from other fields who needs a general understanding of the mathematical kind of thinking. The present volume leads one from Pluto's world of ideas and Euclid's proofs to modern decision theory, utilizing language that can easily be understood by the non-mathematician.

C. V. R.

Elements of Modern Algebra. By Sze-Tsen Hu. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1965. Pp. x + 208. Price $ 9.85.

The book emphasizes materials applied to other branches of mathematics, such as algebraic topology and homological algebra, and gives a more extensive coverage of Abelian groups, including exact sequences, tensor products, and groups of homomorphisms. It also provides a more condensed theory of rings, integral domains, fields, and an elementary presentation of multilinear algebra. The articles contained in this volume are : Sets, Functions and Relations ; Semigroups ; Groups ; Abelian Groups ; Rings, Integral Domains and Fields ; Modules, Vector Spaces and Algebras ; Categories and Functions.

The book will be found useful by undergraduate and graduate students.   C. V. R.

Numbers and Ideals. By Abraham Robinson. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1965. Pp. ix + 106. Price $ 6.55.

This work bridges the gap between abstract methods and concrete application in Modern Algebra and Algebraic Number Theory. It provides an introduction to some basic notions of Algebra and Number Theory, such as rings, fields and ideals, grouped around the theory of algebraic integers in quadratic number fields.

Starting from an elementary level, the book discusses the basic properties of the natural numbers, including primes, prime factorization, and the notion of congruence. This discussion has been followed by the introduction of the notion of integers in quadratic number fields and it is shown that the law of unique prime factorization may not hold in such fields. Ideals are then introduced as a means of re-establishing the law of unique prime factorization in a different setting.

This book will serve as a text for a new kind of introductory course, given, in the freshman or sophomore year, as a preliminary to advanced courses in Algebra and Number Theory.

C. V. R.

Magnetism—*A Treatise on Modern Theory and Materials.* By George T. Rado and Harry Suhl. Volume 2, Part A. *Statistical Models, Magnetic Symmetry, Hyperfine Interactions, and Metals.* (Academic Press, New York and London), 1965. Pp. xv + 443. Price $ 15.00.

This treatise provides a concise yet thorough summary of present knowledge of magnetically ordered materials. Broad in scope, the treatise discusses the most diverse aspects of ferromagnetism, ferrimagnetism, and antiferromagnetism in insulators as well as in metals. Discussions range from quantum mechanical and abstract statistical models to analysis of actual magnetic structures ; from the theory of spin interactions in solids to the phenomenology of ferromagnets ; and from electronic and nuclear resonance effects to neutron diffraction and optical phenomena in magnetically ordered materials. The entire subject is treated from both theoretical and experimental points of view with an emphasis on the physical bases, potentialities, and limitations of magnetism.

This work is of interest to the researcher and the advanced student in physics, chemistry, metallurgy, ceramic sciences, communications engineering, and electrical engineering.

The present volume, in particular, considers : Statistical mechanics of critical behaviour in

magnetic systems ; Statistical mechanics of ferromagnetism ; Magnetic symmetry ; Hyperfine interactions in magnetic materials ; Nuclear resonance in antiferromagnets ; Nuclear resonance in ferromagnetic materials ; Theory of magnetism in rare earth metals.   C. V. R.

Introduction to *p*-Adic Numbers—*Academic Paperbacks in Mathematics*. By George Bachman. Edited by W. Magnus and A. Shenitzer. (Academic Press, New York and London), 1964. Pp. ix + 173. Price $ 3.45.

This book is meant to serve as an introduction to valuation theory. The first two chapters, *viz*., Valuations of Rank One and Complete Fields and the Field of *p*-Adic Numbers, are mainly meant for advanced undergraduate students and first-year graduate students. The amount of algebra required is quite small, and the algebraic results needed for these two chapters are included in the first four sections of the appendix. In addition, exercises have been added to these chapters to give the reader some manipulative facility with the concepts introduced.

The remaining three chapters, *viz*., Valuation Rings, Places, and Valuations, Normed Linear Spaces and Extensions of Valuations, demand more mathematical maturity on the part of the reader. Although most of the material needed for these chapters has been stated in the appendix, this is meant just to serve as a handy glossary for the reader. References have also been supplied for this material.   C. V. R.

Elementary Particle and High Energy Physics —*Lectures Delivered at the 1963 Session of the Cargese Summer School of Theoretical Physics*. Edited by M. Levy and Ph. Meyer. (Gordon and Breach, Science Publishers, Inc., Fifth Avenue, New York 11, N.Y.), 1965. Pp. 374. Price : Paper $ 7.95 : Cloth $ 14.50.

The notes collected in this book reproduce the lectures given in 1963 at the Cargese Summer School of Theoretical Physics. They cover a number of selected topics in Elementary Particle and High Energy Physics.

Some courses are more advanced than others but all should be accessible to students with a good background in field theory and elementary particle physics.

Though mainly aimed at theoreticians the lectures make constant contact with experimental situation, and therefore should also be of some benefit to the experimentalist.

The contents of this volume are : L. Van

Hove—Strong Interactions at Very High Energy ; J. M. Charap—Complex Angular Momentum Theory of Particles with Spin ; M. Jacob— 1. Phenomenological Analysis of the New Resonances. 2. Spin Effects in the Regge Pole Approach to High Energy Collisions ; M. Gourdin —Symétrie Unitaire Modèle de l'Octet ; J. Schwinger—Quantum Theory of Gauge Fields ; Ph. Meyer—Phenomenological Study of Weak Interactions—Selected Topics.   C. V. R

Optical Physics. By Max Garbuny. (Academic Press, New York and London), 1965. Pp. 466. Price $ 14.50.

This book uses a novel approach to a relatively new field of physics. In contrast to the standard approach of texts of classical optics which are mainly concerned with the propagation of light, Optical Physics deals principally with the interaction between light and matter. After introducing atomistic models of varying refinement, the author discusses the processes by which radiation between the infra-red and ultra-violet region is generated, absorbed, and coherently or incoherently re-emitted. Based on these fundamentals, the principles and applications of modern optics are treated with particular reference to such subjects as monochromatic and continuum light sources, broadening of spectral lines, optics of materials, lasers, non-linear optics, and processes of detection. The book evolved from summer courses presented by the author since 1959 at the University of California, Los Angeles. This unified and comprehensive treatment of the modern aspects of optics should be of interest to physicists and engineers in academic or industrial work ; to those concerned with the physics of light or with the generation, transmission, and detection of radiation ; and to graduate students in Physics.   C. V. R.

Some Concepts and Methods in Sub-Tropical Pasture Research. By the Staff of the Cunningham Laboratory, C.S.I.R.O,. Brisbane, Australia. (*Bulletin 47 of the Commonwealth Bureau of Pastures and Field Crops*), 1964. Pp. xii + 242. Price 45 *sh.* 0 *d.* ($ 6.75).

Extensive areas of undeveloped land in the sub-tropics and tropics offer great scope for increased production of meat, milk and animal fibres, especially through the use of ruminants on pastures and forage crops adapted to difficult climates and soils. Since much of the knowledge of pasture development in cool-temperature and "Mediterranean" regions is not

directly applicable in sub-tropical and tropical regions, the techniques for research on tropical pasture are still in a state of flux, and the relevant literature is sparse.

This Bulletin attempts to remedy this situation by setting out the ideas and methods of members of the staff of the Cunningham Laboratory of C.S.I.R.O., a group with some 20 years of experience in the lower latitudes of Australia. It deals with the many problems of synthesizing entirely new pasture communities derived from legumes and grasses introduced from different parts of the world, and of gaining high animal production from infertile soils. The discussion covers all stages of pasture development from the ecological assessment of new regions, through the selection or breeding of new plants (especially legumes), the correction of nutrient and rhizobial deficiencies, chemical analysis of plants and soils, to the evaluation of animal production on statistically designed grazing experiments. C. V. R.

Guides for Basic School Teachers. (The National Council of Educational Research and Training, 114, Sunder Nagar, New Delhi-11.)
Our Plans and Plan Projects. By D. P. Nayar, 1965. Pp. 80. Price Rs. 1·30 ;
Organizing a Village Library. By S. R. Mittal, 1964. Pp. 28. Price Re. 0·40 ;
Preparing Graphic Aids. By S. L. Ahluwalia, 1965. Pp. 28. Price Rs. 1·15 ;
Simple Visual Aids for Social Education. By S. L. Ahluwalia, 1964. Pp. 24. Price Re. 0·85.

These are publications brought out by the National Council of Educational Research and Training for the use of Basic School teachers and Social Workers. The first book on Plans by Nayar gives in layman's language a general idea of India's national efforts in developing a planned economy and deals in some detail with the Third Five-Year Plan. The book includes two maps of India showing the Industrial Projects and the River Valley Projects.

In the pamphlet on "Organizing a Village Library" the author has explained in simple language the need and objectives of a village library, the method of starting, developing and maintaining the library, the type of books to be selected for the villagers, classification and arranging of library books, circulation and follow-up activities, simple rules and regulations to run the library, etc.

The two brochures on visual aids stress the importance of this method of education and explain the various techniques as how to plan and produce visual aids at low cost. The above publications will be handy guides useful to social workers and village instructors.

KRITHIKA SUBBAIAH.

Child Development—A Symposium. (National Council of Educational Research and Training, 114, Sunder Nagar, New Delhi-11), 1964. Pp. 353. Price Rs. 15 or 35 *sh.* or $ 5.40.

This publication, brought out by the National Council of Educational Research and Training, India, is a symposium of articles on Child Development, contributed by authors who are directly concerned with one aspect or other of the subject. Each author is an expert and an original researcher in the particular problem on which he has made his contribution.

The seventeen invited contributions to the symposium are divided into four parts. Part I on "Developmental Aspects of Childhood" contains articles on physical growth and motor development, development during prenatal and neonatal stages, intellectual, emotional, social, and language developments, personality and character development, child and his play, and awareness of child development in India as indicated by rituals and practices. Part II on "Physical and Mental Health in Children" contains articles on common diseases in children, behaviour problems and problems of the exceptional child, and child guidance. Part III is an article on "Environmental Influence on Child Development". Part IV on "Child Education" contains articles on pre-school education, literature for children, training of teachers for pre-schools, and child welfare work in India.

Each article is a comprehensive review of work done in other countries and also in India on the subject, and the references are extensive. The contributors emphasise the need for original research to deal with specially Indian problems against Indian background and Indian environment. The publication is timely, and will no doubt stimulate research workers by showing them the directions along which researches are necessary in this vast, and at the same time urgent, field of child development and child welfare in India.

SUMITRA NARAYAN.

Borides, Silicides and Phosphides. By B. Aronsson, T. Lundström and S. Rundqvist. (Methuen & Co. Ltd., 11, New Fetter Lane, London, E.C. 4), 1965. Pp. 120. Price 20 *sh.* net.

The particular properties of borides, silicides and phosphides, and the possible applications of these compounds as high-temperature structural

materials and also as materials for solid state electronic devices, have stimulated research on them in recent years. This Methuen's monograph gives a critical review of their properties, preparation and crystal chemistry. The authors have collected all relevant information on the subject and presented it as a coherent and up-to-date review of our present knowledge of the chemistry of these potentially important substances.   A. S. G.

Science Dictionary in Basic English. By E. C. Graham. (Evans Brothers Ltd., London). Pp. xvi + 568. Price 30 *sh.*

This Dictionary is intended for the general intelligent reading public interested in science and its modern developments. Its appeal is especially to foreigners whose knowledge of English is limited. Hence Basic English (Ogden's list of 850 selected English words) has been used in bringing out the senses of the words. The Dictionary contains more than 25,000 entries covering all branches of science including engineering and industry. Besides the primary use mentioned above, the Dictionary will also be of help to specialists in one field to understand the new words of specialists in fields other than his own. There are a number of useful tables given at the end.
                                                A. S. G.

Methods in Carbohydrate Chemistry (Vol. V)— *General Polysaccharides.* Edited by R. L. Whistler. (Academic Press, New York-3), 1965. Pp. xxii + 463. Price $ 16.50.

This volume completes the five-volume series concerned with the methodologies required for experimental work on carbohydrates. The earlier volumes were reviewed in these columns as they were issued (see *Curr. Sci.,* 1964, 33, 29). Volume V deals with various methods in the field of polysaccharide chemistry including animal and microbial polysaccharides. The treatment is in seven sections as follows : General isolation procedures ; Preparations ; Chemical analyses ; Physical analyses ; Molecular weight determinations ; Structural methods ; Derivatives. Seventy-five authors have contributed to the various sections that appear under the above heads.

The Editor and Publishers are to be congratulated on bringing out this authoritative series for ready reference and use by workers in carbohydrate chemistry.   A. S. G.

Solid Organoalkali Metal Reagents. By Avery A. Morton. (Gordon & Breach, Science Publishers, 150, Fifth Avenue, New York-11), 1965. Pp. 253. Price $ 14.50 (Professional Edition $ 7.50).

In this book the author presents his new chemical theory of ionic aggregates. Professor Morton has long favoured the view that cations which bind organic anions into insoluble aggregates are not mere inert or static entities but do play a dynamic role and, in fact, they are the more powerful half of ion pairs, and their bonding power must first be satisfied before an anion can function. In other words, according to Morton, an organoalkali metal reagent has electrophilic character before nucleophilic activity. The author's researches extending over nearly 20 years are epitomised in this volume which deserves close study by workers in this special field of the chemistry of organoalkali metal compounds.   A. S. G.

Bridged Aromatic Compounds. By Brandes H. Smith. (Academic Press, New York and London), 1965. Pp. 553. Price $ 14.00.

This is volume 2 of the series of monographs on "Organic Chemistry" brought out by the Academic Press and edited by A. T. Blomquist, the first volume of which on "Carbene Chemistry" was published in 1964. The present work gives a complete account and up-to-date information on what may be called cyclophane chemistry. The book has been compiled and correlated from nearly all available individual studies on bridged aromatic system—chiefly bridged benzene rings. The text also includes bridged ferrocenes and other similar compounds the study of which was only recently started but work on which has been rapidly growing. The author has included exhaustive bibliographical lists and, besides latest published data, also some unpublished data kindly supplied him by many researchers.

The subject-matter is dealt with under the following chapter headings : Nomenclature, Preparation, Chemistry of Bridged Nucleus, Chemistry of the Bridge, Dissymmetry of the Bridged Aromatics, Ultra-violet Absorption Spectroscopy, Infra-red Absorption Spectroscopy, X-Ray and other Structural Studies, NMR and EMR Studies. Finally, there is a Table of Compounds running through more than 70 pages in which are listed nearly all reported bridged aromatic species and some of their more common physical properties like m.p., b.p., yield, etc.

The publication should surely find a place in the bookshelf of all organic chemists.

A. S. G.

Books Received

Ulotrichales. By K. R. Ramanathan. (Indian Council of Agricultural Research, Krishi Bhavan, New Delhi), 1964. Pp. 188. Price Rs. 21·50.

Screening Methods in Pharmacology. By R. A. Turner. (Academic Press, 111, Fifth Avenue, New York), 1965. Pp. xv + 332. Price $ 12.00.

Organometallic Syntheses (Vol. I)—*Transition Metal Compounds.* By R. Bruce King. (Academic Press, New York), 1965. Pp. xii + 186. Price $ 6.50.

Conformation Theory. By M. Hanack. (Academic Press, New York), 1965. Pp. ix + 382. Price $ 14.50.

Advances in Space Science and Technology (Supplement 2)—*Lunar and Planetary Surface Conditions.* By N. A. Weil. (Academic Press, New York), 1965. Pp. ix + 222. Price $ 10.00.

Standard Methods of Clinical Chemistry (Vol. 5). Edited by S. Meites (Academic Press, New York), 1965. Pp. xvii + 288. Price $ 8.50.

The Photochemical Origin of Life. By A. Dauvillier. (Academic Press, New York), 1965. Pp. ix + 193. Price $ 7.50.

The Oligosaccharides. By J. Stanek, M. Cerny and J. Peacacl. (Academic Press, New York), 1965. Pp. 567. Price $ 21.00.

Optical Model of the Atomic Nucleus. By I. Ulehla, L. Gomolcak and Z. Plubar. (Academic Press, New York), 1965. Pp. 147. Price $ 7.75.

University Chemistry. By B. H. Mahan. (Addison-Wesley Publishing Co., Reading, Mass.), 1965. Pp. xii + 660. Price $ 7.00.

Elements of Differential Calculus. By B. S. Fadnis. (Asia Publishing House, Calicut Street, Bombay-1), 1965. Pp. 296. Price Rs. 24·00.

Planets for Man. By S. H. Dole and I. Asimov. (Methuen & Co., Ltd., 11, New Fetter Lane, London E.C. 4), 1965. Pp. x + 242. Price 25 *sh.*

A Hundred Years of Chemistry. By A. Findlay and T. Williams. (Methuen & Co., Ltd., 11, New Fether Lane, London E.C. 4), 1965. Pp. 335. Price 25 *sh.*

Advances in Heterocyclic Chemistry (Vol. 4). Edited by A. R. Katritsky. (Academic Press, New York), 1965. Pp. xiii + 462. Price $ 15.00.

ANNOUNCEMENTS

Award of Research Degrees

Utkal University has awarded the Ph.D. degree in Botany to Shri S. N. Patnaik and Shri Brajagopal Dutta.

Andhra University has awarded the Ph.D. degree in Chemistry to Shri P. Kanta Rao and Kumari V. Rukmini ; and the Ph.D. degree in Geophysics to Shri N. Krishna Brahmam.

Palaeobotanical Society

The Eighteenth Annual Scientific Meeting of the Palæobotanical Society will be held at Birbal Sahni Institute of Palæobotany, Lucknow, on the 21st and 22nd January, 1966.

Indian Society of Theoretical and Applied Mechanics

The Tenth Congress on Theoretical and Applied Mechanics will be held from December 20 to 24, 1965, at the Indian Institute of Technology, Madras. Further information can be had from Dr. M. K. Jain, Indian Institute of Technology, New Delhi.

International Foundry Congress

The 33rd International Foundry Congress will be held in India under the patronage of the Government of India at Vigyan Bhavan, New Delhi, India, from 4th to 9th December, 1966. The main theme of the Congress will be "Technological Developments as Means to Increase Productivity in Foundry Industry". Further information can be had from Mr. R. M. Krishnan, Executive Secretary, National Metallurgical Laboratory, Jamshedpur-7 (India).

Technical Information Centre for Chemical Industry

"The Technical Information Centre for Chemical Industry" has been set up jointly by the Council of Scientific and Industrial Research and the Indian Chemical Manufacturers' Association at Bombay. This Centre will act as an intermediary between the National Laboratories and Chemical and Allied Industries of the country in regard to the supply of technical information. The Industrialists may contact the Scientist-in-Charge of the Centre at 7, Bruce Street (2nd Floor), Fort, Bombay-1 (BR), in connection with their technical problems either personally or through correspondence.

Sir C. V. RAMAN

IN the preceding chapter, it has been demonstrated that the successful reproduction of colour by the well-known half-tone process is made possible by the remarkable power of our eyes to integrate the impression produced by a mosaic of spots of different colours into a single colour determined by the areas occupied respectively by the different colours in the mosaic. In a general way, anyone can satisfy himself of the correctness of this statement by a simple inspection through a magnifying lens of a few half-tone pictures in colour. In the last chapter, a sufficient number of examples have been set out which illustrate this situation. We return to the subject for reason that the integration of colour by the retina is a fact of great scientific interest. Ample material is forthcoming not only to demonstrate the phenomenon but also to place it on a quantitative basis. Further, it can also be observed by using entirely different techniques which reveal other features of interest.

Insect Colours.—In the *National Geographic Magazine* some years ago, an article appeared under the title "Insect Rivals of the Rainbow" containing pictures of no fewer than 263 insects of various sorts which were reproduced in 24 colour plates. In the same magazine in another issue, an article under the title "Strange Habits of Familiar Moths and Butterflies", was illustrated by pictures of no fewer than 162 species of moths and butterflies in 15 colour plates. The range of hues covered by these illustrations is very great. Hence these reproductions are valuable as an aid to the study of the relationship between the mosaics of colour and the visual impressions which they produce.

As has already been set out in the preceding chapter, the representation of colour by the half-tone process is achieved by the use of just four printing inks, *viz.*, black, yellow, magenta (or process red) and cyan (or process blue) on white paper. If we assume the total available area of a given mosaic to be divided into 16 equal parts and the parts filled by the four inks range in number from 0 to 16 (the total, of course, should not exceed 16, the unfilled part being white), the number of the different possible colours thus resulting would

be quite large. Even only binary combinations, *e.g.*, yellow and white, magenta and white, cyan and white, yellow and black, magenta and black, cyan and black, yellow and magenta, yellow and cyan, magenta and cyan, would give us a great number of different hues. Examining the insect pictures through a magnifying lens, each of these binary combinations and the characteristic hues which they generate can be recognised in individual insects or in the individual areas of colour displayed by them. We shall content ourself with a few selected examples.

We may begin with some strong colours. The red areas are represented by magenta ink and appear of a deeper and darker hue when a substantial proportion of magenta is replaced by black. Various shades ranging from a bright yellow to a deep orange are exhibited by mosaics of which the areas are occupied by yellow and magenta inks in different proportions. Various shades ranging from a bright green to a greenish-blue are exhibited by areas of which cyan ink occupies a substantial part, the rest being occupied by yellow ink. Various shades ranging from a bright blue to a deep purple are exhibited by mosaics occupied by the cyan and magenta inks in varying proportions. If, in addition, areas of black ink are present, the colours appear to be of a deeper and darker hue. *Vice-versa*, if areas of white are present, the colours are lighter and brighter.

Interference Colours.—Excellent illustrations of the manner in which our eyes integrate colour-sensations appearing in areas which are contiguous are furnished by the colours of thin films. Reference has already been made in an earlier chapter to the remarkable fact that when Newton's rings are formed between two plates of glass, one of which is flat and the other has radius of curvature of 3·6 metres, the interference pattern exhibits no colour at all when viewed from the usual distance of distinct vision, even though the rings are themselves seen quite clearly. The pattern occupies an area of over one square centimetre and what is actually visible is a dark central patch surrounding which appear a succession of bright and dark rings, some six or seven in number

which approach more closely as we proceed outwards. Viewed under a low magnifying power a few more rings can be seen and counted in the pattern, but the pattern remains achromatic. To observe colour, the interference pattern has to be viewed from close quarters using fairly high magnifying powers. All the rings then show brilliant colours.

Newton's rings can also be observed on a much smaller scale using surfaces of which the radii of curvature are not large. In such cases, even merely to see the rings, we require a fairly high magnification, and it is to be remarked that the colours in such cases are scarcely noticeable. The greater the magnifying power employed, the more clearly are the colours seen.

By using two glass plates which deviate from planeness by a very little, Newton's rings can be obtained on such a large scale that brilliant colours are exhibited and are conspicuously visible without any optical aid. Likewise, using two circular disks of optically plane glass, a wedge-shaped air film may be obtained between them by exerting pressure at the end of one common diameter while leaving the other end free. The straight fringes exhibited by such films being on a large scale, a brilliant succession of colours is exhibited by the film. A comparative study of such interference colours when viewed from various distances is particularly instructive.

The colours of Newton's rings even observed on a large scale disappear from view when viewed from a distance of a few metres, the pattern then appearing achromatic. This change is not sudden but progressive and can be followed step by step as the distance of the ring-pattern from the observer is increased. Remarkably enough, the colours which first cease to be observed are those of the rings immediately surrounding the first dark minimum. The colours of the outer rings which are narrower nevertheless continue to be visible till the observer has moved much further away. Finally, these also appear achromatic.

The straight fringes of a wedge-shaped film behave rather differently. The spacing of the fringes makes a much closer approximation to uniformity than is the case with Newton's rings. The fringes of higher order are thus of about the same width as those of lower orders. Here again, we find that it is the fringes of lower order that cease to exhibit colour first as the distance of the observer is progressively increased. The colours of higher orders on the other hand show a less rapid weakening and indeed they continue to be recognisable so long as the rings themselves can be discerned.

Still another type of behaviour is shown by films of which the interferences of higher orders are enclosed by those of lower orders and are more widely separated than the latter. Such films can readily be obtained by clamping two thick plates of glass together at their edges. At close quarters, the interferences of all orders show brilliant colours. As the observer moves away, the fringes of lower orders lose colour and become achromatic and they are followed in succession by those of higher orders. But the central fringe of highest order which is very broad continues to exhibit brilliant colour even when the observer is far away from the glass plates.

It is clear from these facts of observation that the replacement of the individual colours in a given area by an integrated colour-sensation manifests itself only when the angular dimensions of the area as perceived by the eye are small enough. It is also significant that differences in luminosity continue to be observed when differences in colour cease to be perceived. That there is a relationship between the effects now under consideration and the phenomena of visual acuity is thereby made evident. But what exactly is the nature of such relationship requires further elucidation.

A further question arises in regard to the precise nature of the colour synthesis which is effective when a mosaic of areas exhibiting different colours come under observation. So far as the present observations go, it would seem that the general ideas which emerged from the studies on the visual synthesis of colour described in earlier chapters are valid also in the present context.

CHEMISTRY OF THE COLOUR TESTS FOR CHALKONES, FLAVANONES AND AURONES

H. G. KRISHNAMURTY AND T. R. SESHADRI

Department of Chemistry, University of Delhi, Delhi-7

THE commonly used reagents for colour tests of anthoxanthins are the following : (A) Mg-HCl ; (B) Na, Hg-HCl ; (C) Zn-HCl ; (D) NaBH₄-HCl ; (E) Ac₂O-H₂SO₄ ; (F) SbCl₅ in CCl₄ ; the tests (D) and (E) are of more recent introduction. The colourless or yellow solutions of anthoxanthins develop colours ranging from orange to purple, which fade on keeping. A useful account of the mode of carrying out the tests (A), (B), (C) and (F) and their specificities is given by Geissman.[4] The present paper is intended to present some observations on the tests given by flavanones, chalkones and aurones.

Tests (A) and (B) for Flavanones.—In these tests, substituted flavanones give bright red to purple colours. Geissman and Clinton[3] made a detailed study to isolate the possible reduction products and to identify the substances responsible for the colour. Their experimental data led them to the conclusion that the colours are not due to flavylium salts as originally thought but arise by the action of acid on the reduction products of flavanones such as flavan-4-ols, flavpinacols and of reduction products of 2'-hydroxy chalkones arising from flavanone ring opening. An important observation made by them was that 5, 7, 4'-trimethoxyflavan-4-ol (prepared by catalytic reduction of 5, 7, 4'-trimethoxy flavanone) produced a deep carmine colour with acid and this was identical with the colour produced in Na, Hg-HCl reaction. They formulated the sequence of steps (Chart I) leading to the formation of the substance responsible for colour which was considered to be the carbonium ion (4). Similar ions derivable from flavpinacols were also considered to contribute to the colour. Certain relevant experiments have now been done with the reagent D with the object of verifying these formulations and they are presented here.

Test (D) : (i) *Flavanones.*—This test[6] consists in reducing the anthoxanthin with sodium borohydride followed by acidification with conc. hydrochloric acid. Among the flavonoids only flavanones were reported to give a positive reaction. Rowell and Winter[12] have used this test for the estimation (spectrophotometric method) of flavanones present in citrus fruits. Reduction of flavanone with sodium borohydride is a straightforward reaction leading to the formation of flavan-4-ol as the only product. The formation of deep colour in this reduction procedure is undoubtedly due to the action of acid on a flavan-4-ol.

(ii) *Chalkones.*—Contrary to what was recorded by Horowitz,[6] chalkones could be selectively reduced at the carbonyl function using sodium borohydride in methanol-ethanol solution. In this manner, the chalkone (5) (m.p. 160°) gave a colourless crystalline substance (m.p. 104°) whose properties (chemical, U.V. and I.R.) are in agreement with the structure (6). It produced purple colour when treated with a strong acid. This colour and the one obtained with 5, 7, 3', 4'-tetramethoxy-flavan-4-ol[9] (2) (m.p. 117°) are spectrally identical (λ_{max} 565 mμ). A noteworthy observation is that while the compound (6) produced colour immediately, the flavan-4-ol gave colour of maximum intensity after a small time interval. This difference is understandable since for the formation of the quinonoid chromophore (4 a or 4 b) the heterocyclic ring in the flavan-4-ol has to open out under the influence of acid. These observations provide evidence to demonstrate that carbonium ion of the type (4) arising in accordance with Geissman's scheme is involved in the colour test.
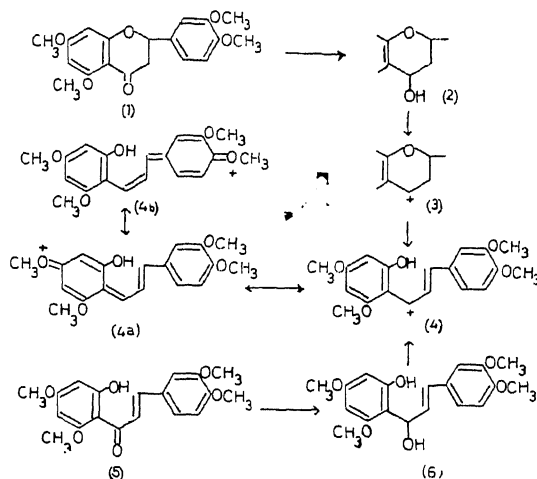

CHART 1

A second and more satisfying evidence in support of the above scheme is provided by the following experiments. Selective reduction of 4-methoxy chalkone (7) with sodium borohydride gave a colourless unsaturated alcohol (8) (m.p. 48°; lit.[2] 52°). Its I.R. spectrum showed the presence of hydroxyl and no carbonyl. It is different from the propanol (9) prepared from the chalkone (7) by Pt, H₂ reduction and it also gives the propanol by further catalytic reduction. It is very sensitive to acid and gives an immediate red colour with ethanolic HCl while the propanol (9) showed no change.
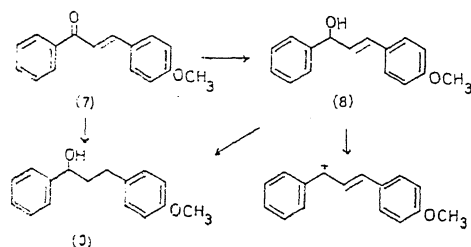
CHART II

Further evidence for the structure of the chromogenic compound is provided as follows: The diol (10) obtained[9] by the reduction of the corresponding dibenzoyl methane gave on treatment with mineral acids in the cold a red purple colour spectrally identical with the colour produced by 5, 7, 4'-trimethoxy flavan-4-ol. The possible course of the reactions is shown in Chart III.
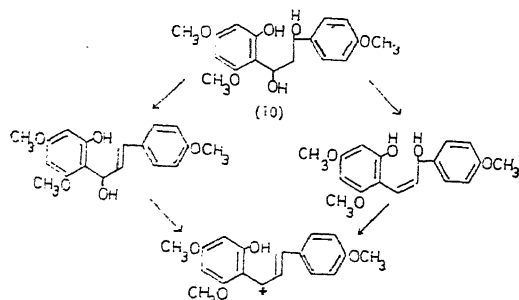
CHART III

The expectation that flavpinacols can also contribute to the colour in tests (A) and (B) has now been confirmed. 5, 7, 4'-trimethoxyflavanone by Al. Hg-alcohol reduction provides the flavpinacol[10] as the chief product. It gives deep red-violet colour with mineral acids and this behaviour is similar to that of 5, 7, 4'-trimethoxyflavan-4-ol. It may be pointed out that substituted (hydroxy or methoxy) flavpina-

cols cannot be isolated under the condition of test (A) due to their sensitiveness to acids.

The new results summarised above fully substantiate Geissman and Clinton's scheme and it is clear that their observations pertain to the deep colour (initial colour) that develops rapidly in the tests (A) and (B). They contended that flavylium salts may not be present in the final acid solution even as minor components. We described[9] in an earlier paper the conversion of flavan-4-ols and the reduced dibenzoyl methanes into flavylium chlorides. As already mentioned the deep colour developed in the cold by the flavan-4-ol (2), and the alcohols (6) and (10) is not stable; on standing for some time it is lost. On the other hand if the original solution is heated there is gradual change to yield finally a stable orange or red solution. Taking as an example 5, 7, 4'-trimethoxyflavan 4-ol or the diol (10) the initial deep colour had $\lambda_{max.}$ 545 mμ (ethanol-conc. HCl) and after boiling for 45 min. the orange red solution had $\lambda_{max.}$ 475 mμ and this value remained constant. From the final red solution apigeninidin trimethyl ether was isolated. The substance (6) showed similar colour changes and we have established by chromatography and absorption spectrum the presence of 5, 7, 3', 4'-tetramethoxyflavylium chloride in the final acid solution. These changes mean that the carbonium ion is undergoing oxidative (aerial) cyclisation to give flavylium salt. The poor yield (about 8%) of the flavylium salt in all of these cases could be explained on the basis that a predominant competitive reaction involves polymerisation to yield phlobaphenes. A formal representation of this conversion is shown in Chart IV (cf. flavan 3 : 4-diol-anthocyanidin change[14]).
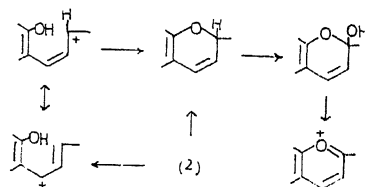

CHART IV

It may be mentioned here that flavan 3, 4-diol (11) derivatives (natural and synthetic) unlike flavan 4-ols do not give such intense colours in the cold. They give, however, red pink colours due to 3-hydroxy flavylium salt along with phlobaphenes in warm acid solution. This difference from flavan 4-ols could be explained on the following basis. Even after

ring opening to give enol (12) the extended conjugation as in (4) is not possible on account of its tendency to go into the keto form (12 a).
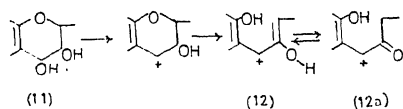

(11) (12) (12a)

CHART V

(iii) *Reduction of Aurones.*—One can expect that the carbonium ion (15) (Chart VI) derived from an aurone should also exhibit colour. In order to establish this point 4, 6, 4'-trimethoxy aurone (13) was subjected to reduction using NaBH₄. The properties of the product clearly showed that the aurone carbonyl underwent reduction. The product (14) produced a purple colour with conc. HCl in ethanol solution and the colour is stable since the structure cannot undergo further change.
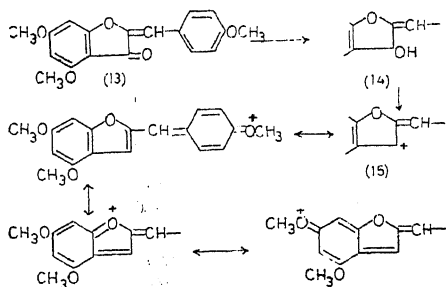
CHART VI

Test (E).—King and White⁵ found that substituted (hydroxy, methoxy) chalkones, flavanones, aurones and 2-hydroxy-2-benzyl coumaran-3-ones in acetic anhydride solution produce deep colours (orange to purple) when treated with a drop or two of concentrated sulphuric acid. The test is negative with other flavonoids. The mechanism of this reaction has not been explained. The following observations throw light on it.

Chalkones and Flavanones.—That chalkones and flavanones dissolve in concentrated sulphuric acid and produce vivid colours is well known.⁴ In the first case an acid-base interaction leading to the carbonium ions (18) is believed⁴ to be involved. A large bathochromic shift in the visible colour occurs when acetic anhydride is employed as the solvent. The cause of colour in the acetic anhydride-sulphuric medium on chalkones (16) appeared to be due to changes summarised in the formulas 16→19 (Chart VII). The consequence of the last acetylation step

(18 → 19) is to favour the retention of the charge on the carbon and thus shift the equilibrium largely to the carbonium ion side. In line with this reasoning we find agents like HClO₄ and ZnCl₂ (Lewis acid) which are capable of generating acetylium ions¹ from Ac₂O serve equally well in the place of sulphuric acid.⁵
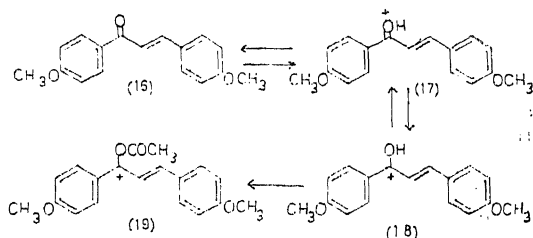

(16) (17) (19) (18)

CHART VII

The essential chromogen is evidently –CO–CH = CH– flanked on either side by aryl groups. Flavanones, which lack this system still produce colour. We were originally inclined to interpret the process as involving acid catalysed ring opening to 2'-acetoxy chalkone which gives the colour.

To test this possibility the action of Ac₂O-H₂SO₄ on 2'-hydroxy-3, 4, 4'-trimethoxy chalkone and the isomeric 7, 3', 4'-trimethoxyflavanone was studied. Firstly, the colour in both the cases was found to be spectrally identical. The chalkone gave intense colour ($\lambda_{max.}$ 542 mμ, $E^{1\%}_{1cm.}$ 1406) instantaneously while the flavanone showed only weak absorption ($\lambda_{max.}$ 542 $E^{1\%}_{1cm.}$ 132) to start with but showed increase in intensity with time (30 sec. — 132 ; 2 min. — 142 ; 10 min. 162 ; 20 min. 216 ; 30 min. 216), reaching a constant value after 25 min. In a search for the products of the reaction, the chalkone and the flavanone were separately kept in Ac₂O solution (0·2% w/v) containing two drops of con. H₂SO₄ at 10–15°. The reaction time was varied from 10 min. to 60 min. The deeply coloured solution was then poured into ice-cold water. The colour disappeared immediately. The chalkone gave nearly quantitative yield of its 2'-acetoxy derivative (m.p. 90°) when the reaction time was 10 min., increase in time seriously brought down the yield. The flavanone was recovered after reaction time of 10 min. and 2'-acetoxy chalkone was present in only small amount and seemed to undergo other changes. When the reaction time was increased by 20 min. the recovery of the flavanone was poor. Longer reaction always led to coloured products and deeply coloured aqueous solution.

The 2'-acetoxy chalkone also behaves similarly on long treatment. Owing to these side reactions it has not been possible to demonstrate the conversion of flavanone into 2'-acetoxy chalkone under the conditions of test (E). The spectrophotometric measurements are definite about the identity of the chromogen. These observations led us to the conclusion that the positive response given by flavanone is due to the formation of traces of chalkones formed during the reaction as a result of ring opening and their immediate conversion into coloured products; the chalkones are indeed extremely sensitive in this test. The flavanone samples used in our work were spectrally and chromatographically pure and gave no detectable ferric colour and therefore our samples were free from any chalkone contaminant (King and White expressed the possibility that their flavanone samples were probably impure).

Reaction with Acetylium Perchlorate Reagent.—Support for the suggestion that in test (E) the effective reagent in the acetylium ion is provided by the use of acetylium perchlorate ($CH_3CO^+ClO_4^-$) prepared[13] from acetyl chloride and anhydrous sodium perchlorate in glacial acetic acid solution. Solution of chalkone (5) and flavanone (1) were used in two solvents. (*a*) acetic anhydride, (*b*) carbon tetrachloride or chloroform. The observations are as follows: Chalkone (5) in solvent (*a*) gave purple colour and in (*b*) deep red. the colour development in both cases being instantaneous. Obviously there is direct electrophilic attack by acetylium ion at the carbonyl. The colour in (*a*) is the same as that shown in test (E). The flavanone (1) gave in (*a*) a very faint red purple only after about five minutes and the colour deepened on standing. whereas in (*b*) it gave no red colour and even with excess reagent the solution turned orange yellow on long standing. Thus positive and rapid response is shown by chalkones and not flavanones and they could therefore be distinguished. The lack of reaction of flavanones in non-polar solvent (*b*) shows that there is need for the preliminary formation of chalkone which does not take place in (*b*). but does occur in polar solvent (*a*). The above observations explain why in test (E) using acetic anhydride. and sulphuric acid flavanones also give colour.

Colours of Chalkones in the Tests (D) and (E).—The colours produced by some typical chalkones in tests (D) and (E) are given in Table I: from them the following important points could be noted with regard to test (D): (1) Unsubstituted chalkone and the 2'-hydroxy compound

give no colour; at best a transient and feeble red is produced. (2) Hydroxyl or methoxyl in the 4-position alone is sufficient to give red colour while a hydroxyl or methoxyl at the 4'-position produces only orange-red. (3) A combination of substituents at the 4' and 4 positions is favourable and produces deep colours. (4) The presence of 4-amino or 4-dimethylamino groups confer stability to the colour. The reduction products from these amino chalkones behave like acid-base indicators.

TABLE I

	Name of the chalkone	Test (D)[a] $\lambda_{max.}$ (mμ)	Test (E)[b]
1	Chalkone	No colour	Yellow
2	2'-Hydroxy	,,	,,
3	4'-Hydroxy	480–485	,,
4	4'-Methoxy	(Unstable red)	Orange
5	4 Methoxy	550	Red
6	4:4'-Dimethoxy	565	Purple
7	2'-Hydroxy-3, 4, 4' trimethoxy	(Unstable blue)	Blue changing to red
8	2'-Hydroxy-3, 4, 4' trimethoxy	570	Purple blue
9	2'-Hydroxy-4 : 4' : 6' trimethoxy	540	Deep pink
10	2'-Hydroxy 3 : 4 : 4' : 6'-tetramethoxy	560	Purple
11	4-Dimethylamino	495	Wine red
12	2'-Hydroxy 4-dimethylamino	550	Red

[a] About 2 mg. of the chalkone in ethanol (30 c.c.) was reduced with $NaBH_4$ and then treated with conc. HCl (8 c.c.). Measurements were made as rapidly as possible because of the tendency of the colours to fade.

[b] Spectrophotometric measurements of the colours showed broad maxima. The colours described here were observed in about 0·01% solution in Ac_2O (10 c.c.) and one drop of H_2SO_4.

Test (E) for Aurones and 2-Hydroxy 2-Benzyl Coumaran-3-ones.—The colour development is rapid with these compounds. In the case of 2-hydroxy-2-benzyl coumaran-3-ones dehydration to give aurones (20 to 14) is an easy process and constitute the first steps in the colour test and subsequent changes (14 — 21 — 21 a. Chart VIII) run parallel to those of chalkones.
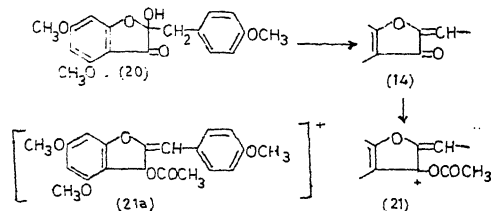

CHART VIII

Summary.—A study has been made of the sodium borohydride-hydrochloric acid reaction of flavanones. This reaction is given by chalkones and aurones also. These results provide support for the explanation offered by Geissman and Clinton for the colour reactions of flavanones with magnesium-hydrochloric acid, and sodium amalgam-hydrochloric acid. In all these cases the same type of chromophore

$$Ar-\overset{+}{C}H-CH=CH-$$ is formed. Borohydride reduction products of flavanones and 2'-hydroxy chalkones when heated in alcoholic hydrochloric acid produce flavylium salts. A study of the acetic anhydride sulphuric acid test for chalkones, flavanones and aurones shows that the chromogen involved is Ar-CO-CH=CH-Ar and that the flavanone ring should open in order to develop colour. The reaction involves the attack by acetylium ions at the carbonyl of the above chromogen giving $-\overset{+}{C}(OAc)-CH=CH-$.

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THE INFLUENCE OF SOME AGRICULTURAL PRACTICES ON THE ENZYME ACTIVITY OF COCONUT WATER

M. NAGARAJAN AND K. M. PANDALAI

Chemistry Department, Central Coconut Research Station, Kasaragod

IT is now well established that a particular plant itself is the best indicator of the nature and quantity of nutrients it can absorb and utilise from the soil. Thus, the use of the plant tissue analysis, particularly foliar composition studies for diagnosing mineral deficiencies of crop plants such as rubber, oil palms, groundnuts, tea, cocoa, etc., has now become very popular. Suitable methods have been standardised to overcome the usual difficulties experienced in the case of perennial plants in the matter of leaf sampling from inaccessible heights from the ground level, availability of samples of comparable physiological age, possible nutrient level fluctuations on account of climatic changes and so on. In his studies on the potash content of nut water as a guide to the manuring of coconut palm, Salgado[1] found that potash content of nut water affords a relatively simple method of assessing potash availability in the soil in relation to the needs of the palm. He claimed superiority for this method over the conventional methods of soil analysis assuming coconut water to be analogous to plant sap in indicating the physiological status of the palm and of the soil conditions on which it grows. We examined the pattern of enzyme activity in the nut water in relation to cultural and manurial practices received by the palm to see whether this could be more useful and reliable for diagnostic purposes. Indeed the determination of enzyme activity in plants has been shown to provide information about the effect fertilizers have on plant by Hofmann[2] who concluded that the amount and the activity of enzyme depends on the nature of the soil, on the fertilizers used and the method of cultivation during the vegetative period. He also stressed that enzyme activity orientates crop quality, stability on storage, germinating power and certain other properties and that the determination of enzyme activity of plants is also simple to carry out and exact and comparable values are usually obtained. The activity of the enzymes catalase and saccharase in estimating the biological activity

and fertility of soils has been stressed by Kozlov.[3]

To obtain representative average samples nut water of mature nuts from palms of comparable age were collected in dry weather in the early morning when all the assimilation products of previous day have been transported from the leaves and before renewed assimilation commenced. The analysis was carried out immediately and directly as the samples needed no preparation or pre-treatment. Selected trees belonged to medium yield groups, standing in the permanent observation plots of this Research Station, where three sister plots are maintained, the first receiving absolutely no cultivation or manuring, the second receiving cultivation operations only while the third receives both cultivation and manurial treatments. These three plots under three entirely different experimental conditions afforded the ideal sample for this study. The activity of the three oxidising enzymes catalase, peroxidase and polyphenolase usually found active in all growing plants, were determined by the methods described by Sumner and Somers[4] and Hawk et al.[5] Suitable modifications wherever found necessary were standardised and adopted. For catalase assay, the reaction mixture consisted of 5·0 ml. of phosphate buffer (pH 6·8), 1·0 ml. of 0·2 N. H_2O_2, 2·0 ml. of fresh coconut water (treated with $CaCO_3$ and filtered through glass wool) and incubated for exactly 30 minutes in the ice-bath. The reaction is stopped by the addition of 5% sulphuric acid and the remaining H_2O_2 is determined using 0·01 N. $KMnO_4$. For peroxidase assay the reaction mixture consisted of 10·0 ml. of 0·25% pyrogallol, 7·0 ml. of phosphate buffer (pH 5·3), 1·0 ml. 0·025% H_2O_2 and 1·0 ml. of fresh centrifuged nut water. 1·0 ml. of 5% H_2SO_4 was added after 5 minutes to arrest the reaction and the optical density was directly measured in the photovolt colorimeter using 420 filter. A reaction mixture consisting of 10·0 ml. of 0·25% pyrogallol, 8·0 ml. of phosphate buffer (pH 6·5), 1·0 ml. of centrifuged nut water served for the assay of polyphenolase activity. After allowing the reaction for exactly 10 minutes, 1·0 ml. of 5% H_2SO_4 was added and the optical density was directly measured as above. Suitable controls were run with distilled water in place of the nut water as well as by initial inhibition of the enzyme by addition of sulphuric acid. Typical

results showing the pattern of enzyme activity in the nut water samples are given in Table I.

TABLE I

Enzyme activity	Not cultivated or manured	Cultivated only	Cultivated and manured
Catalase (Micromoles of H_2O_2 decomposed per milligram of nitrogen in 30 minutes)	130·50	98·74	62·88
Peroxidase (Optical density of purpurogallin formed per milligram of nitrogen in 5 minutes in 20 ml. reaction mixture)	1·6070	0·8971	0·1285
Polyphenolase (Optical density of purpurogallin formed per milligram of nitrogen in 10 minutes in 20 ml. reaction mixture)	0·7142	0·3781	0·1072

These show that the nut water sampled from the trees receiving no attention had the maximum activity in the case of all the three enzymes, those from the trees given cultivation only being comparatively less while the samples from the trees receiving manuring and cultivation showed the least enzyme activity indicating that agricultural practices do exert measurable influence on the oxidising enzymes present and active in nut water. The possible scope for this type of studies to serve as guides in the selection and adoption of the usual agricultural practices, using carbohydrate, fat and protein splitting enzymes in coconut water is receiving careful attention.

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LETTERS TO THE EDITOR

RAMAN AND INFRA-RED SPECTRA OF 2-AMINO METHYL PYRIDINES

VENKATA RAMIAH et al.,[1,2] studied the inter-molecular associations of amino pyridines, amino quinolines and 2-amino methyl pyridines. It was shown by these authors that these molecules form intermolecular hydrogen bonds of N-H—N type and the equilibrium has been explained in terms of monomer and dimer species. Recently Dhingra et al.,[3] have studied the association of amino methyl pyridines by proton magnetic resonance method and calculated the equilibrium constants. In the present work, we report the vibrational frequencies—both Raman and infra-red of 2-amino 3-methyl and 2-amino 6-methyl pyridines. The compounds which were of Eastman Kodak, were distilled under reduced pressure and the Raman spectra were recorded with a Fuess glass spectrograph with a dispersion of 19 Å/mm. in λ 4358 region and a Hilger Raman source unit. These substances are colourless after distillation, but get gradually coloured when exposed to mercury light. Therefore, while recording the Raman spectra, the substance in the Raman tube was replaced by fresh material every ten minutes. 2-amino 6-methyl pyridine which is in liquid condition after distillation, gets gradually solidified in the Raman tube after some time. Addition of a few drops of CCl_4 to the liquid material enabled the authors to keep the compound in the same state. The infra-red spectra of these compounds were recorded by Perkin Elmer Model 21 double beam spectrophotometer with NaCl optics. The spectra in the 3 μ region were obtained with Perkin Elmer Model 221

TABLE I

Raman and infra-red spectra of 2-amino methyl pyridines (Frequencies in cm.⁻¹)

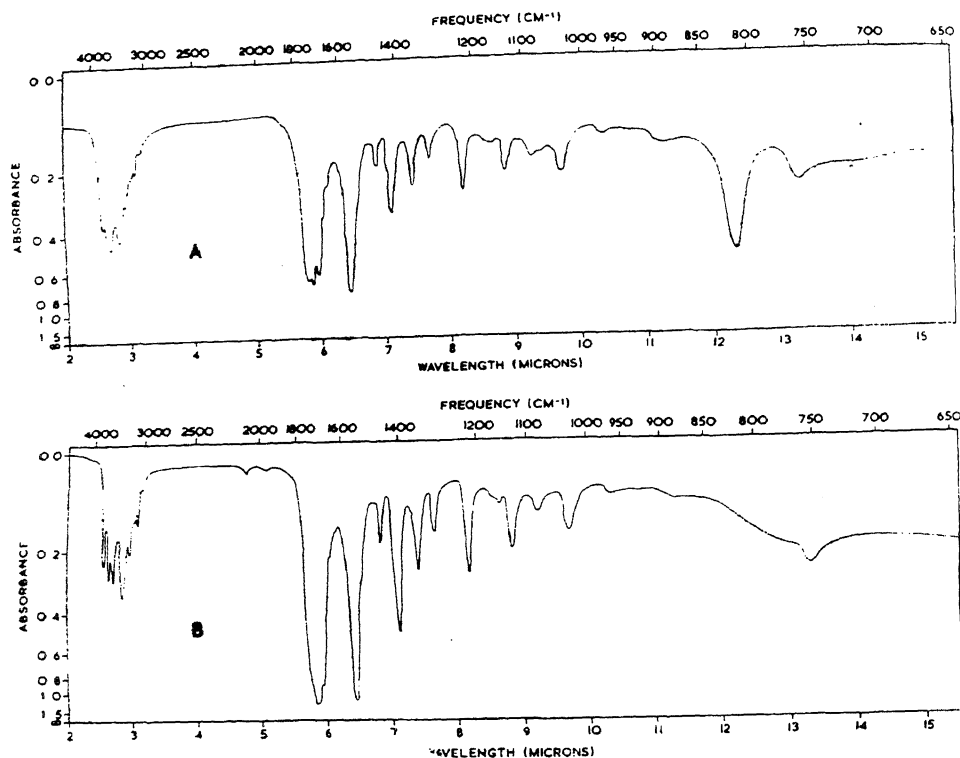| 2-Amino 3-Methyl pyridine			2-Amino 6-Methyl Pyridine		
Raman	Infra-red		Raman	Infra-red	
	Pure amine	In CCl₄		Pure amine	In CCl₄
..	..	3500 (m)	..	..	3500 (m)
..	3452 (s)	3402 (m)	..	3452 (s)	3402 (m)
..	3327 (s)	3307 (m)	..	3322 (s)	3309 (m)
3140 (4)	3182 (s)	3172 (s)	3140 (4)	3177 (s)	3172 (s)
3049 (5)	3022 (w)	3026 (w)	3047 (5)	3040 (w)	3040 (w)
..	2972 (w)	2975 (w)	..	..	..
..	2942 (w)	2942 (w)	..	2941 (w)	2941 (w)
2876 (2)	2917 (w)	2917 (w)	2860 (3)	2888 (w)	2882 (w)
..	1624 (s)	1610 (s)	..	1626 (s)	1608 (s)
1591 (4)	1582 (m)	1582 (m)	1585 (3)	1585 (m)	1585 (sh)
..			1568 (6)		
1451 (3)	1450 (s)	1450 (s)	1449 (1)	1462 (s)	1462 (s)
..	1430 (m)	1432 (sh)	..		
1378 (5)	1378 (m)	1378 (m)	1373 (6)	1376 (w)	1372 (w)
1320 (6)	1315 (w)	1315 (w)	1330 (4)	1334 (s)	1327 (s)
..	1287 (m)	1287 (m)	..		
1271 (4)	1270 (m)	1270 (m)	1277 (4)	1278 (m)	1275 (m)
..	1192 (m)	1192 (m)	1158 (2)	1161 (m)	1160 (m)
1135 (1)	1130 (w)	1130 (w)	1121 (1)	1110 (vw)	1106 (vw)
1076 (4)	1076 (m)	1076 (m)	..	1080 (m)	1075 (w)
1033 (1)	1031 (w)	1031 (w)	..	1032 (w)	1032 (w)
970 (1)	992 (m)	990 (m)	982 (7)	990 (m)	990 (m)
..	950 (vw)	950 (vw)	927 (1)	930 (vw)	930 (vw)
..	..	..	854 (1)	..	..
..	770 (s)	..	..	780 (vs)	..
743 (9)	740 (w)	..	730 (9)	730 (w)	730 (w)
586 (1)	..	..	..	..	..
524 (3)	..	..	535 (2)	..	..
323 (1)	..	..	308 (1)	..	..
269 (2)	..	..	..	..	..
169 (2)	..	..	216 (4)	..	..

FIG. 1. Infra-red spectra of (A) 2-Amino 6-Methyl pyridine; (B) 2-Amino 6-Methyl pyridine in CCl₄.

spectrophotometer using a spectral slit width of about 2 cm.⁻¹ The spectra of the compounds in solution of CCl₄ were recorded with matched cells of 0·1 mm. thickness. The Raman and infra-red frequencies are given in Table I and the infra-red spectra of 2-amino 6-methyl pyridine (liquid and in CCl₄ solution) are shown in Fig. 1. The frequencies in Table I indicate that the spectra of the amines have three absorption bands in the N-H stretching region, but in solutions, the frequencies recorded are at about 3500, 3402, 3307 and 3172 cm.⁻¹ The spectra of these compounds in the region 3500 cm.⁻¹–3172 cm.⁻¹ were recorded at various concentrations and with increasing dilution of the amine, it was observed that the intensity of the bands at 3307 cm.⁻¹ and 3172 cm.⁻¹ decreased while the bands at 3500 cm.⁻¹ and 3400 cm.⁻¹ became more prominent. Therefore the bands at 3500 cm.⁻¹ and 3402 cm.⁻¹ are assigned to the asymmetric and symmetric stretching vibrations of the free NH₂ group and the other two frequencies at about 3307 cm.⁻¹ and 3172 cm.⁻¹ to the same modes of vibration of the bonded NH₂ group. The Raman line at 3140 cm.⁻¹ is therefore due to the symmetric stretching vibrations of the bonded NH₂ group.

The infra-red spectra of pure amino methyl pyridines have two absorption bands at about 1626 cm.⁻¹ and 1608 cm.⁻¹ and in dilute solution of CCl₄, the band at higher frequency disappeared and the one at lower frequency became intense. Therefore the band at higher frequency is assigned to the inplane deformation of the bonded NH₂ group and the one at lower frequency is due to the same mode of vibration of the free NH₂ group. A detailed discussion of the assignments of the other fundamentals of these and other related molecules will appear in our later publication.

Dept. of Physics,   K. VENKATA RAMIAH.
University College of   V. VENKATA CHALAPATHI.
  Science,
Osmania University,
Hyderabad-7 (A.P.), *August 4, 1965.*

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THERMAL ETCH PATTERNS ON SILVER CRYSTALS

THERMAL-ETCHING technique has been successfully employed to study dislocations in metals, alloys and metal crystals.[1-4] The studies described in this communication are concerned with thermal etch pits on the various facets developed during the growth on the high purity melt-grown single crystals of silver. The crystals were grown in a graphite boat kept in a vacuum furnace which was very slowly cooled by mechanical reduction of current in the heating coil. The fall in temperature was about 10° C. per hour. The boat was prepared by scraping off material from a graphite rod and thus in one case instead of uniform curvature at the bottom, plane sides were formed.

When the crystal was taken out from such a boat it had developed facets and these were found to be crystallographic planes from the shape of etch patterns on the surfaces of the specimen. The measurements of interfacial angles, taking face with square etch pits as (100) plane for reference, were carried out with great care. Comparing these data with interfacial angles for a cubic crystal it was found that the facets on the crystals were more or less parallel to (100), (221), (321), (110) and (210) crystallographic planes. The nature of the thermal etch pits on different facets has shown that the indexing of the facets on interfacial angle measurements are in fair agreement.

A crystal with such different facets was heated to 850° C. in high vacuum for about $1\frac{1}{2}$ hours. Subsequent examination of these facets with optical microscope has revealed a variety of etch patterns. Figure 1 is a photograph of (100) facet. A large number of square etch pits have been produced on (100) facet under these conditions of thermal etching. The average pit density was found to be $1 \cdot 8 \times 10^5$/cm.[2] The pit depth was found to be of the order of one to two microns as estimated by means of a light profile. Since the thermal etching was carried out in vacuum, the surface tension of the metal becomes comparatively large and this results in the formation of shallow pits. A few pits are seen to be flat-bottomed. It is believed that the formation of flat-bottomed pits is due to the movement of dislocation during the process of thermal etching. However, no one-to-one correspondence between etch pit and dislocation has been established and the possibility of some of the pits at the sites of impurity clusters cannot be completely ruled out.

Further increase in the time of etching did not show any increase in the pit density. Examination of the (221) facet gives pits which are triangular in shape. The density of these pits and their depth were found to be of
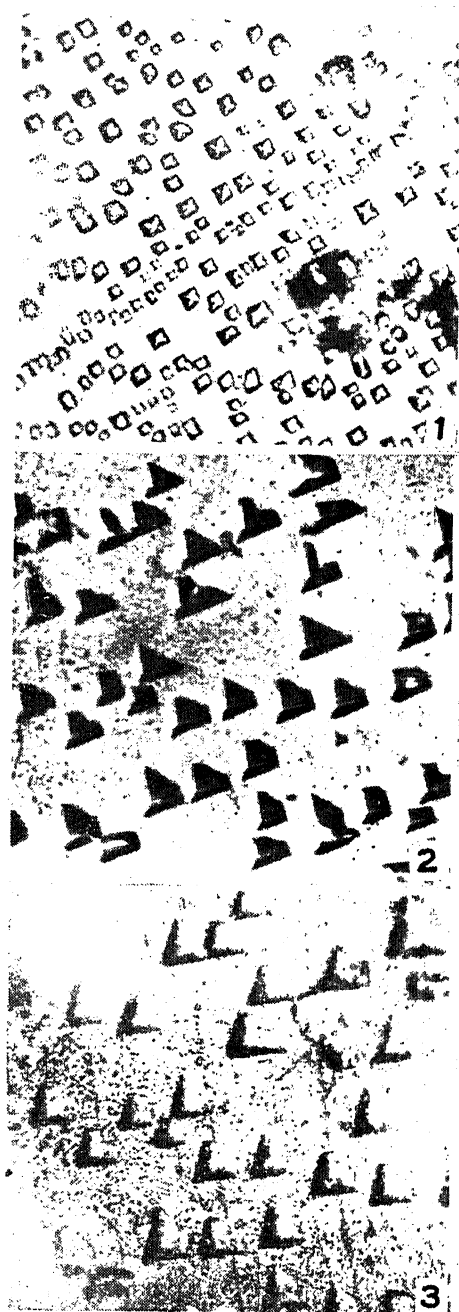
FIGS. 1-3

the same order as on (100) facet. Figure 2 shows the formation of such triangular pits.

The same facet was re-examined under optical microscope after further heating for half an hour. The pit density was found to be of the same order as before but the general appearance of the surface is spoiled due to the enlargement of the pits.

It is interesting to observe in Fig. 3 a triangular hillock with the orientation opposite to that of pits shown by an arrow. It is suggested that this particular triangular hillock might have been formed by the condensation of vapour during the process of cooling at the site of a dislocation.

Examination of (321) plane revealed triangular pits with a density of $1.5 \times 10^5/cm.^2$ The pits were much smaller in size as compared to that on other planes and they became circular on further etching with no change in their density. The face (210) revealed the presence of circular pits.

These types of etch pits on silver have not been reported so far and thermal etching gives good information. The number of etch pits were independent of the time of etching and the small difference in the order of density of the etch pits may be due to impurity sites on the faces also.

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Physics Department,   H. B. PATEL.
Faculty of Science,
M.S. University of Baroda,
Baroda-2, *August* 2, 1965.

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SYNTHESIS OF (±) LATIFOLIN DIMETHYL ETHER

LATIFOLIN, the chief constituent of the heart-wood of *Dalbergia latifolia*, was assigned the novel skeleton of diphenyl propene (I, a) by Balakrishna et al.[1] The position of the two free hydroxyl groups has been unequivocally proved by Darshan Kumari et al.[2] by conversion of the diethyl ether (I, b) to the corresponding α, α-diphenyl propene and to

2:4-dimethoxy 2':5-diethoxy benzophenone and also by the synthesis of these two compounds.

In this communication we report a synthesis of the dimethyl ether of (±) latifolin. In preliminary experiments we tried to build up the skeleton using Claisen migration of the 3-methoxy-phenyl 2-methoxy-cinnamyl ether (II, a) as the key step but all attempts to prepare this compound by reacting o-methoxy cinnamyl chloride and monomethyl resorcinol under a variety of conditions failed. In an alternative route to the ether (II, a) o-tosyloxy cinnamyl bromide, obtained from o-tosyloxy allyl benzene and N-bromo succinimide gave with monomethyl resorcinol, 2-tosyloxy cinnamyl 3-methoxy phenyl ether (II, b) in good yield. Mild alkaline hydrolysis followed by methylation gave the desired methyl ether (II, a) as a gum (U.V. $\lambda_{max.}^{EtOH}$ 253 mμ and 290 mμ) which failed to crystallise. Attempted migration of it by heating at 220° C. or in refluxing diethyl aniline or decalin failed to give any alkali-soluble product. Hence this route was abandoned but the reactions involved are being investigated.

I
a, R = H
b, R = C₂H₅

II
a, R = CH₃
b, R = —SO₂—⟨ ⟩—CH₃

III   V

IV
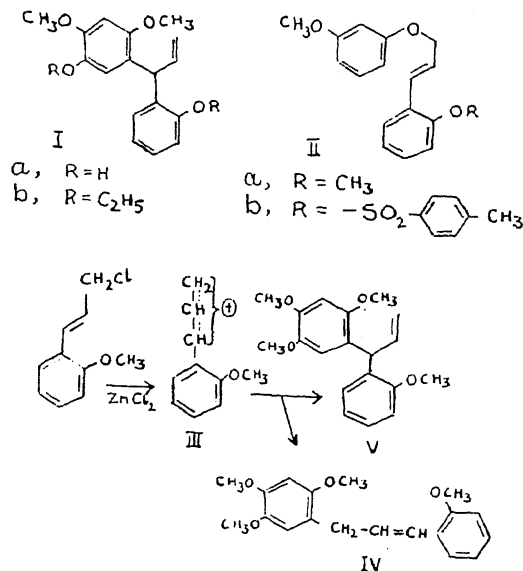
A more attractive route to the latifolin skeleton would be to follow the path of biogenesis suggested by Seshadri[3] which involves coupling between a C_6 and a C_9 precursors. When o-methoxy cinnamyl chloride (1 mol.) was added slowly to a solution of 1:2:4-trimethoxy benzene (1 mol.) and fused zinc chloride (excess) in refluxing tetrahydrofuran

or stirred for several hours in dry ether at room temperature, a gummy product was obtained. Thin layer chromatography of it revealed the presence of 13 spots, two of which closely followed each other and constituted the major amount, the rest being only in minor quantities. The upper of the two spots was due to latifolin dimethyl ether as shown by co-chromatography with the natural sample. The other lower spot was due to its isomer (IV) as shown by co-chromatography with an authentic sample prepared by Perkin reaction of 2 : 4 : 5-trimethoxy dihydrocinnamic acid and *o*-methoxy benzaldehyde.

This mixture of two substances was separated from other spots by chromatography of the crude product on basic alumina. Further chromatography on a column of silica gel impregnated with silver nitrate followed by repeated crystallisation from methanol furnished ($\pm$) latifolin dimethyl ether (V), m.p., 64–65° C. The product was identical with the methyl ether of the natural sample in I.R. (CCl_4) and U.V. and gave identical R_f in T.L.C. on silica gel G.

The reaction clearly proceeds by extraction of chloride ion by the zinc chloride (aluminium chloride also serves but leads to more extensive side reactions) followed by partial isomerisation of the resulting allylic carbonium ion (III). Electrophillic attack by this equilibrium mixture then gives the desired product (V) along with (IV).

Department of Chemistry,   DARSHAN KUMARI.
University of Delhi,   S. K. MUKERJEE.
Delhi-7, *September* 6, 1965.   T. R. SESHADRI.

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PARAMAGNETIC RESONANCE IN GAMMA-IRRADIATED THIOSULPHATE AT 77° K

THE authors have reported on the e.s.r. spectra of gamma-irradiated alkali thiosulphates at room temperature.[1,2] During some low temperature irradiation experiments with thiosulphates,[3] the electron resonance spectra of $Na_2S_2O_3.5H_2O$ and $Na_2S_2O_3$ irradiated at 77° K were obtained at the same temperature.

A commercial Gamma Cell 220 Co[60] Irradiation Unit was employed for irradiation and the e.s.r. spectra of the irradiated solids were obtained with a Varian Associates V-4500

E.P.R. spectrometer (X band) containing a model V-4530 low temperature resonant cavity with a quartz Dewar flask. The preparation of materials and the experimental details have been described in earlier communications. For gamma irradiation of solids at 77° K, the samples were sealed in 4 mm. O.D. pyrex tubes and the tubes were placed in a well-insulated Dewar flask (O.D., 5" and height, 7") containing liquid nitrogen. The Dewar was placed in the gamma cell and the samples were irradiated to a total absorbed dose of 3×10^6 rads.

To eliminate the main paramagnetic signal in the irradiated glass tube, the upper irradiated part of the sample tube was annealed for a few minutes by flaming the glass tube with a Bunsen burner to the appearance of sodium flame, while the sample was still immersed in liquid nitrogen in the Dewar. The tube was then completely immersed in liquid nitrogen and then was quickly inverted under the liquid. The irradiated solid sample was then tapped down to the annealed end of the glass tube. The samples were examined in the Varian spectrometer in the quartz Dewar filled with liquid nitrogen and were not warmed before examination.

Some of the irradiated samples were annealed for an hour at − 160° C. (in a 2-methyl butane-liquid nitrogen bath) and at room temperature and their e.s.r. spectra were then obtained at 77° K. The irradiated $Na_2S_2O_3.5H_2O$ and $Na_2S_2O_3$ appeared deeply colored at 77° K. Although no change in coloration took place on warming to − 160° C., there was a rapid change in color when the compounds were warmed to room temperature. The greenish-brown hydrate became brown and the violet $Na_2S_2O_3$ was bleached.

The e.s.r. spectra (first derivative of the absorption curve) of gamma-irradiated $Na_2S_2O_3.5H_2O$ and $Na_2S_2O_3$ are shown in Figs. 1 and 2 respectively. Although a positive identification of the free radical or (radicals) is difficult, the following tentative comments can be made. The low field structure might possibly be due to *g*-anisotropy and an interpretation of the spectra in terms of g_x, g_y and g_z, based on the method of Kneubühl[4] can be attempted. However, the presence of two different kinds of bonds in the thiosulphate ion and the annealing characteristics observed in the present experiments might indicate that there may be at least two kinds of magnetic centres trapped in the rigid polycrystalline matrix at the low temperature. In Fig. 1, lines A and B decay quite rapidly with

the increase in temperature. Annealing at room temperature for one hour very much simplifies the e.s.r. pattern but traces of line B are still visible. This is to be contrasted with the single line spectrum obtained for $Na_2S_2O_3 . 5 H_2O$ irradiated at room temperature.[1] We propose that this second species (line B in Figs. 1 and 2) with g factors around 2·03 may be a

sulphur and oxygen. Line A in both the e.s.r. spectra is slightly asymmetric while B centres could indicate isotropic g values.
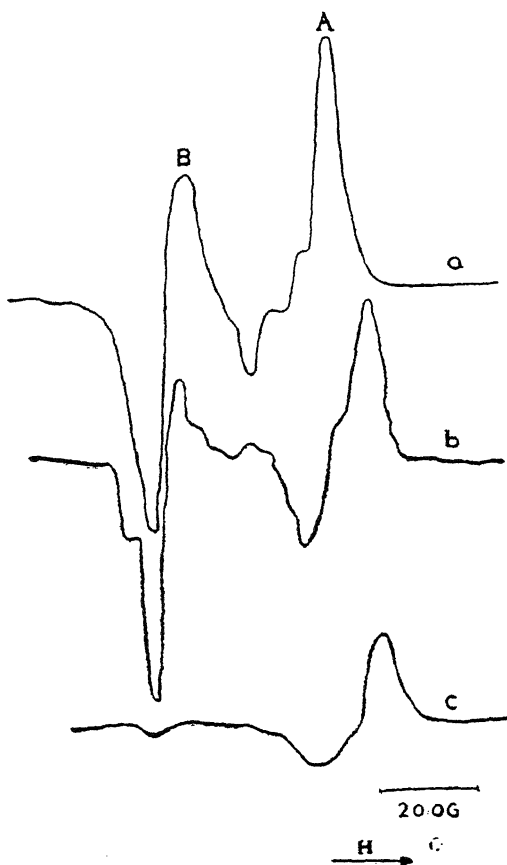
FIG. 1. E.S.R. spectrum of $Na_2S_2O_3 . 5 H_2O$ at 77° K, irradiated to $3·2 \times 10^6$ rads at 77° K; (*a*) spectrum without annealing, (*b*) after annealing for one hour at $-160°$ C., (*c*) after annealing for one hour at room temperature.

FIG. 2. E.S.R. spectrum of $Na_2S_2O_3$ at 77° K, irradiated to 3×10^6 rads at 77° K; (*a*) spectrum without annealing, (*b*) after annealing for one hour at $-160°$ C., (*c*) after annealing for one hour at room temperature.

sulphur radical involving much spin-orbit coupling. The decay characteristics are slightly different for the anhydrous salt (Fig. 2). While there is not much change in the radical concentration at $-160°$ C., annealing at room temperature drastically reduces line B, but there is almost a proportionate increase in line A. Irradiation of the solids might break down the S-S bond in the thiosulphate ion and line A could be due to a free radical containing
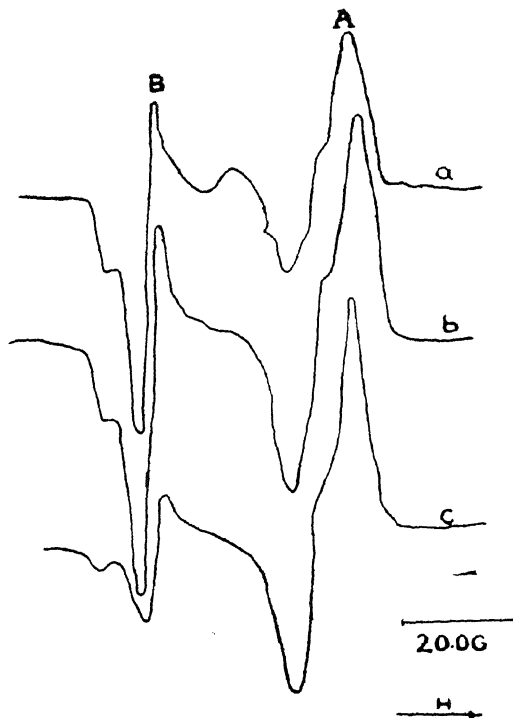
Dept. of Chemistry and   D. S. MAHADEVAPPA.*
   Chemical Engineering,   R. L. EAGER.
University of Saskatchewan,
Saskatoon, Sask., Canada, *July* 1, 1965.

* Present Address : Department of Post-graduate Studies and Research in Chemistry, Manasa Gangotri, University of Mysore, Mysore-2, India.

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QUILON LIMESTONE FOUND AT KIDANGAYARA, A NEW LOCALITY

THE occurrence of fossiliferous limestone and carbonaceous clay, observed while deepening a well at Kidangayara (58 C/12 ; 9° 4' : 76° 35' 30") about four miles south-west of Suranad and seven miles north-west of Padappakara in the Quilon District, was recently brought to the notice of the writer. On visiting the site, it was found that the large blocks of limestone excavated from the well were already removed by local people and the debris heaped near the well consisted of carbonaceous clay and small blocks of limestone the largest of which measured about a foot in length. The limestone bed was under water at the time, but it was reliably learnt that it was at a depth of about one hundred feet. This new occurrence indicates that the Quilon limestone occupies a fairly large area. The limestone bed is rarely seen as outcrops but its occurrence at depth, as observed in wells, was first reported by General Cullen nearly a century ago at Padappakara, about seven miles north-east of Quilon town. Similar occurrences have been noted at Paravur, Nedungolam and Chathanur[1] which are about eight to nine miles south-east of Quilon. The limestone was described as bluish-grey, very tough and richly fossiliferous with *Orbiculina malabarica* as the characteristic fossil. At Chathanur there are two beds of limestone separated by a bed of carbonaceous sandy clay. The lower bed is a coral limestone. Probably the same is the case at Kidangayara.

The limestone is grey, tough and richly fossiliferous. Molluscan fossils are most abundant. The carbonaceous clay is laminated, plastic and dark-coloured with a distinct greenish tinge. A few nodules of chert were also collected, but it is difficult to say whether they came from the limestone or clay. The chert is almost black or brown in colour and intimately coated with calcareous matter which imparts a smooth surface. Some of the nodules are locally corroded.

A large number of fossils has been collected either by picking directly from the debris or by carefully separating from the limestone and clay. The fossils are marine and well preserved, and most of them are sufficiently good for palæontological studies. They comprise foraminifers, gastropods, lamellibranchs, solitary and colonial corals, echinoderms, bryozoans (?), worms (?), etc. The residue, obtained by washing the carbonaceous clay, on examination under the binocular microscope, has revealed a few foraminifers, one millimetre in diameter,

provisionally identified as *Operculina*. *Orbiculina malabarica*,[1] the characteristic fossil of the Quilon limestone, was not seen in any of the Kidangayara specimens examined.

The Tertiary sequence in Kerala consists of the Warkala beds, and the underlying Quilon limestone.[2] Based on fossil studies the age is determined as Burdigalian or upper part of Lower Miocene[3] and considered equivalent to upper Gaj.

The writer is indebted to Dr. K. S. Pillai, Research Officer in Chemistry, for his interest in the work and valuable help in the field.

Department of Geology,   K. K. MENON.
University of Kerala,
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RELATIONSHIP BETWEEN THE GWALIOR AND JAHAZPUR FORMATIONS IN RAJASTHAN*

JUST north of the Vindhyan ranges near Bundi, greenish shales, siltstones and slates with a few bands of dark vitreous impersistent quartzites and a limestone band are seen. The argillaceous rocks are well exposed further towards north-west for nearly eight kilometres. Several dolerite dykes are also seen intruding these sediments. Coulson considered these sediments to be Gwaliors and indicated the difficulty in separating them from the metamorphosed rocks closely resembling the Aravallis. Heron first thought that the Gwaliors were younger than the Aravallis but was convinced later that the two were the same varying only in their degree of metamorphism.

Near Sabalpura and Jahazpur, two elongated synclines expose a quartzite-shale-dolomite sequence and these were mapped as Jahazpur Series by Brandshaw. This group was correlated with the Raialo Series by Heron on the basis of the presence of dolomite. The sections, however, do not indicate a break in sedimentation.

The argillaceous rocks show a gradual increase in the grade of metamorphism towards north-west. Shales and slates become phyllitic and these change to biotite-mica schists with andalusite, staurolite and garnet. At places, retrograde metamorphism is indicated by staurolites changing to chlorite. Nearer Deoli and west of Jahazpur the schists are progressively granitised from south-east to north-west,

An area of quartz vein-rich schists shows increase in granitisation finally to migmatite with mica-beryl-bearing pegmatites. These granites are typically late-tectonic and the increase in the grade of metamorphism is closely related to granitisation. The rocks within the Jahazpur syncline are not affected by granitisation probably due to obstruction by the outer quartzite. But at the same time the quartzite and limestone of the Sabalpura syncline are much cut up by pegmatites and granite.

Near Deoli and Jahazpur, the strike of the beds is N. 35° E.–S. 35° W. and towards south it changes to N. 65° E.–S. 65° W. The beds are folded into tight upright isoclines and the axial planes are steeply inclined towards north-west or north. Foliation has been superimposed on bedding in the metasediments (schists); yet the siliceous bands are recognised in many places.

The rocks are well exposed and the sections indicate a continuous sequence of geosynclinal sediments. Even the quartzites exposed near Rajmahal and considered to be Delhis, are part of this sequence.

Systematic geological mapping of the area is being conducted and the senior author is working on an hypothesis that the entire sequence of sediments referred to above is part of a geosynclinal deposition much earlier in age than the undoubted Aravalli rocks which overlie the Banded Gneissic Complex with a first-order unconformity near Udaipur (Poddar). The granites and pegmatites found near Jahazpur and further west have to be correlated with an orogeny which was responsible for the Banded Gneissic Complex.

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Rajasthan Circle,   B. D. Gupta.
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SALINITY TOLERANCE AND CHLORIDE ION REGULATION IN A HOLEURYSALINE TELEOST, *TILAPIA MOSSAMBICA*

THERE have been several studies on the salinity tolerance, osmotic and ionic regulation in fishes.[1-5] The exotic mouth breeding cichlid *Tilapia mossambica* was introduced into Indian waters in 1952 and was shown to withstand a wide range of salinity.[6] In the present investigation the salt tolerating capacity of this freshwater fish has been confirmed and the chloride ion regulation in the tissue fluids of the fish adapted to different saline media has been studied.

The fish were collected from local freshwater ponds and tanks where they do not have any access to saline waters in their natural habitat. The fish were fed daily with mosquito larvae and fried rice. Various concentrations of sea water beyond 100% were obtained by evaporating the normal sea-water. The normal sea-water salinity was 32·5‰. After the programmed treatment in various experimental media the fish were stunned with a blow on the head and the muscle tissue was cut out of the animal. The tissue was gently squeezed and a fluid sample of about 0·2 ml. was collected. Since the tissues were not crushed the sample thus obtained is the extracellular fluid. The chloride concentration was estimated by electrometric titration with $AgNO_3$ using a Gallenkamp potentiometric microtitrator. The sampling and the estimation were carried out at room temperature (27° C.).

It was found that the fish withstand direct transfer to 50% and 100% sea-water without any apparent adverse effects. The fish do not survive in higher concentrations beyond 100% sea-water when they are transferred directly. But on gradual transfer with a week's sojourn in 50% and 100% sea-water and with a fortnight's sojourn in 125, 150 and 175% sea water the fish could be taken to 200% sea water. However, the fish fail to survive in any concentration beyond 200% sea-water (salinity = 65‰). This is in accordance with the previous finding on the same species in Indonesia.

TABLE I
Tissue fluid chloride of Tilapia mossambica *in various salinities*

Medium		Medium salinity ‰	Medium Cl mM/l.	Tissue fluid chloride mM/l.	S.D.
Tap-water	..	..	..	96·0 (6)*	± 3·9.
50%	Sea-water	16·0	276·0	124·8 (6)	± 7·08
100%	,, ..	32·5	552·0	183·0 (6)	± 7·33
150%	,, ..	48·0	834·0	263·0 (6)	± 8·85
200%	,, ..	65·0	1096·0	324·3 (6)	±12·82

* The figures in parenthesis indicate the number of estimations.

It is evident from the chloride concentration of the tissue fluid of the animals adapted to different salinities (Table I) that in all media except freshwater which is the natural medium,

Tilapia mossambica behaves like a marine teleost exhibiting remarkable powers of hypo-regulation. While it is true that there is a steady rise in the chloride level of the tissue fluid when the fish is upgraded through various salinities, this rise is negligible when compared to the rise in the chloride level of the medium. It is clearly seen that the secret of the survival of

considered of interest to analyse the muscle of *Chelone mydas* (Boulenger).

The flesh of an adult male turtle, measuring 765 mm. in total length, caught by a fisherman off Visakhapatnam on October 10, 1964, was analysed for chemical composition according to standard procedures.[1-7] The results are presented in Table I. It is to be expected that the

TABLE I

Chemical composition of the muscle of the turtle Chelone mydas (Boul.) (Per 100 gm. of muscle)

Moisture gm.	Proteins gm.	Fat gm.	Ash gm.	Phosphorus (P_2O_5) mg.	Calcium mg.	Iron mg.	Copper mg.	Cobalt mg.	Molybdenum mg.
80·47	15·35	0·76	2·12	510·0	201·0	34·00	0·21	0·20	0·02

this fish upto a salinity of 65‰ lies in its fantastic powers of chloride regulation in such a way that in all salinities from 100% sea-water to 200% sea-water the chloride concentration of the tissue fluid is consistently maintained at a level about 1/3 of that of the medium. Detailed studies on the regulation of various cations and the metabolic aspects of osmotic and ionic regulation are in progress.

Department of Zoology,   R. RAMAMURTHI.
Sri Venkateswara University,
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CHEMICAL COMPOSITION OF THE FLESH OF THE TURTLE *CHELONE MYDAS* (BOULENGER)

As far as the authors are aware, there is no reference in literature to the chemical composition and nutritive value of the flesh of turtles from the Indian coast. It was therefore

percentage composition of the ten substances analysed may vary with age, sex and season. However, a general comparison of the percentage composition of these substances in turtle flesh with that of a few common Indian fishes[8,9] and mammals[8] indicates that the water content of turtle flesh is close to that of fishes but higher than in mammals, the fat content lower than in most fishes (even allowing for fluctuation due to size, sex and season). It is worthy of note that the iron content is significantly higher than in fishes.[10]

Department of Zoology,   TH. APPA RAO.
Andhra University,   S. DUTT.
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OVULE AND SEED OF *SECHIUM EDULE* Sw.—A REINVESTIGATION

Sechium edule Sw., a native of tropical America, is widely cultivated, usually between 4,000 and 7,000 ft. altitude, in Eastern Himalayas, Assam, Uttar Pradesh, and some parts of Southern India. The plant is a tendril climber with tuberous root and pyriform fruit. Each fruit contains a large, ovate, compressed and pendulous seed which shows many uncommon features for the Cucurbitaceæ, *e.g.*, leathery testa, hypogeal germination and vivipary. Kratzer[1] studied a few ovules of *S. edule*, while Reiche[3] gave a rather detailed account of its seed and fruit development. The latter author observed that unlike all other Cucurbitaceæ,[4,5] the ovular epidermis in *S. edule* remains undivided and fuses with the inner layers of the pericarp. The organisation of seedcoat in *Sechium edule*, thus, shows a fundamental departure from an otherwise remarkably uniform pattern of seedcoat development of the family. It was, therefore, considered worthwhile to reinvestigate ovule and seed of *S. edule*, material of which was collected from Darjeeling.

The pyriform ovary bears a single bitegminal pendulous ovule with its micropyle facing the stigma. The nucellus has a long beak which reaches the orifice of the micropyle (Fig. 1). Each ovule receives three or, rarely, four vascular traces which are clearly seen in transections (Figs. 2, 3). All the vascular traces come close to each other as they travel down the raphe and eventually fuse to form a single strand in the chalaza (Figs. 4, 5). The fused bundle extends into the outer integument up to its tip (Fig. 1). Individual vascular strands, as well as their fused product, give out branches which traverse the inner layers of the outer integument.

The outer integument consists of 15 to 20 cell-layers at the mature embryo-sac stage (Fig. 6) while the inner integument is only 4 or 5-layered at the sides and 6 to 10-layered toward the chalazal end. The latter degenerates and is completely lost as the embryo assumes the globular shape.

After fertilization the epidermal cells of the outer integument begin to divide periclinally. The divisions initiate at the micropylar and chalazal ends and gradually progress towards the middle portion. The first division of the ovular epidermis cuts off an inner layer (*e'*) which does not divide further as known for other Cucurbitaceæ.[4,5] The cells of the outer layer divide again forming an outer (*e*) and an inner (*e″*) layer (Fig. 7). The second division takes place in almost all cells at the micropylar and the chalazal ends, and along the lateral faces of the compressed seed but on its flat surfaces the cells divide only at some places. The subepidermal layer is, therefore, discontinuous on the flattened sides of the seed. During further development of seeds, the cells of *e*, *e″* and *e'* enlarge and become filled with starch grains. The remaining layers of the outer integument also store starch grains and become aerenchymatous. The air-spaces are more conspicuous in the outer layers while the inner layers are progressively more compact. The seedcoat remains parenchymatous and is closely adpressed to the inner epidermis of the pericarp.

The seedcoat encloses the remnants of the nucellus, 2-4 layers at the sides and more layers at the ends of a seed, the remains of the endosperm between the cotyledons only, and the embryo. The hypocotyledonary root axis of the embryo is conical and the primordia for the seminal roots are organised in the seed. The epicotyl bears seminal leaves. The seed germinates within the fruit and the seedling shows epicotyl carrying the primary leaves growing out of the fruit. The cotyledons remain inside the seed and fruit.

Sechium belongs to Sicyoideæ, a tribe having only uniovulate genera. Puri[2] reported that the single ovule in *Sicyos angulatus* receives its vascular supply from three different sources in the ovary. These bundles in *Sicyos* fuse in the funiculus before passing into the ovule. The ovule in *Sechium* also receives 3 or 4 vascular traces but their fusion is deferred till they reach the chalazal end. The vascular supply to the ovules of *Sechium* and *Sicyos* suggests that due to reduction in the number of placentae and ovules, perhaps all the ventral carpellary traces of different carpels in these plants are passing into the single ovule of the uniovulate ovary which, thus, represents a derived condition.

The seedcoat development in *S. edule* is in complete conformity with that of other Cucurbitaceæ.[4,5] Interestingly, the cells of the testa in *Sechium* remain unlignified. This coupled with its fusion with pericarp obscures a clear differentiation of various zones which are characteristic of the mature cucurbitaceous seed, *i.e.*, seed epidermis, subepidermal tissue of lignified cells usually, sclerenchymatous layer of strongly lignified cells, aerenchyma, and chloren-
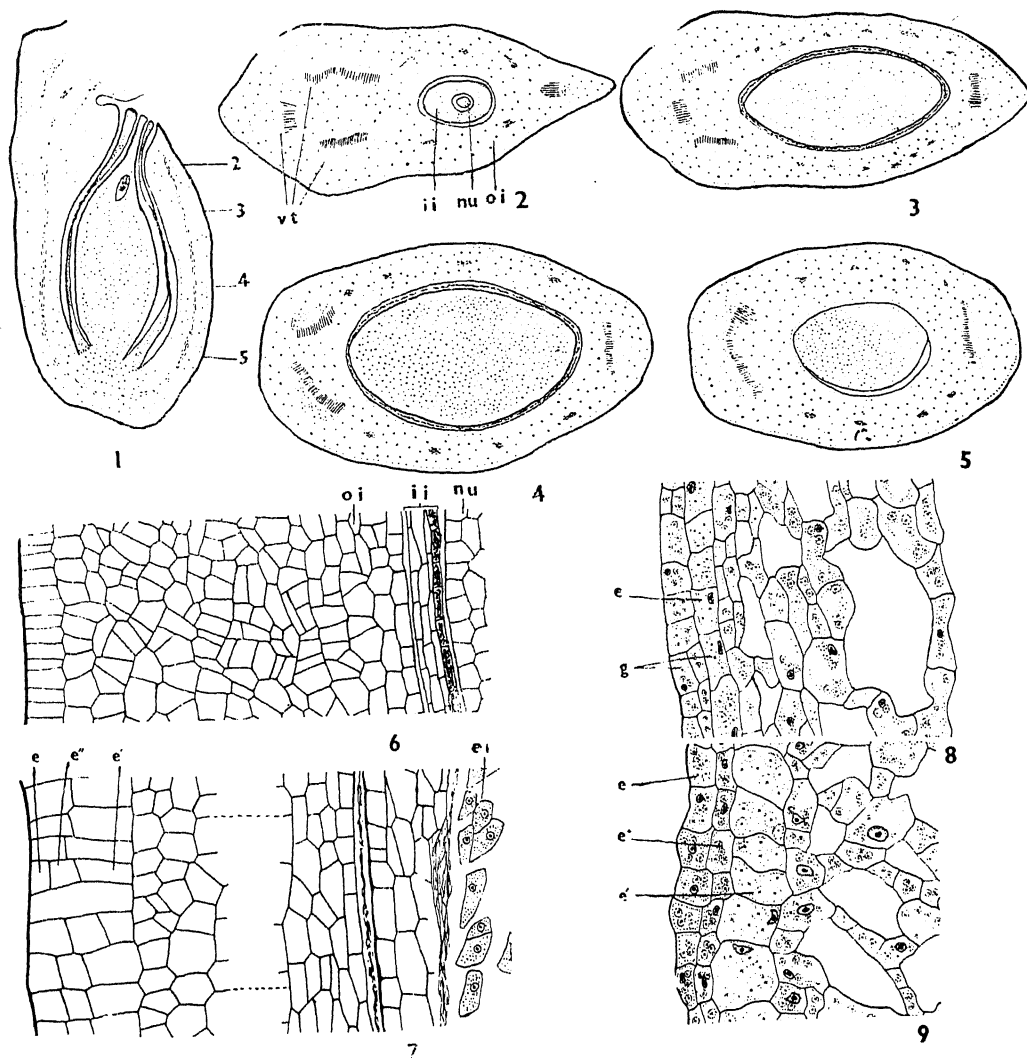
FIGS. 1-9. *Sechium edule* Sw. Fig. 1. L.s. ovule, × 29. Figs. 2-5. Transections of ovule at levels 2-5 in Fig. 1, × 29. Fig. 6. L.s. part of integuments. × 350. Fig. 7. L.s part of seedcoat, note the periclinal divisions in the outer epidermis, × 350. Fig. 8. L.s. part of almost mature seedcoat from the flattened sides, × 260. Fig. 9. T.s. part of seedcoat from ateral sides, × 260. *en*, endosperm; *g*, starch grains; *ii*, inner integument; *oi*, outer integument; *vt*, vascular traces.)

chyma. The lack of lignification of the testa can be attributed to its adopted method of germination, vivipary. Reiche[3] who described that the ovular epidermis remains undivided in *Sechium* gave only one figure (his Fig. 2) showing inner layers of pericarp and the outer layers of seedcoat. He evidently did not follow the changes in the outer integument in detail and as mentioned above was, therefore, led to the erroneous conclusion.

The author is grateful to Professor Bahadur Singh, Assistant Director, National Botanic Gardens, Lucknow, and to Dr. B. Tiagi, Head of the Botany Department, University of Rajasthan, for their interest and help in this work.

Department of Botany,   DALBIR SINGH.
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AFRICAN TETRAPLOID SPECIES OF *ORYZA*

SPECIES differentiation and evolution in the genus *Oryza* is a subject of interest and also of controversy. It is a small genus consisting of only 22 species (Tateoka, 1963) and despite many valuable contributions, the taxonomy of the species of *Oryza* has many areas of disagreements. In the course of cytogenetical study in series *Latifoliœ* Tateoka of the genus, new observations regarding interrelationships and taxonomic status of the tetraploid species ($2n = 48$) indigenous to Africa were made and are presented below. Materials included in the study consisted of both live and herbarium specimens. The plant materials of live-specimens of the species studied were obtained through the courtesy of the National Institute of Genetics, Japan, and the Central Rice Research Institute, Cuttack. The herbarium sheets were kindly provided by the Central National Herbarium, Calcutta, and from the different herbaria of the Botanical Survey of India.

There are three taxa of this genus, in Africa which are reported to be tetraploids. They are *O. eichingeri* Peter, *O. schweinfurthiana* Prod. and *O. punctata* Kotschy ex Steud. The somatic chromosome number of the former two has been determined to be 48 (Shama Rao and ¬Seetharaman, 1955 ; Bouharmont, 1962) while that of *O. punctata* has not yet been determined. However, Tateoka (1963) reports that both diploid and tetraploid forms of *O. punctata* have been found among the collections from West Africa gathered by Dr. Furusato of the National Institute of Genetics, Japan. Chevalier (1951) described a species, *O. ubangensis*, found in West Africa and records it as having fringed ligule. Tateoka (1963) tried in vain to find the type specimen of *O. ubangensis* in any of the herbaria in U.S.A. and Europe, he visited. It is not available in any of the herbaria in India also. Therefore, it has to be considered that the *nomen* is invalid. Andrews (1956) in *The Flowering Plants of the Sudan* described *O. schweinfurthiana* as having fringed ligule. However, fringing of ligule has not been observed in any of the collections of the three African tetraploid species examined so far. It is not known whether the species listed as *O. schweinfurthiana* by Andrews and *O. ubangensis* of Chevalier are one and the same.

Among the three validly described taxa, *O. punctata* has widest distribution ̦being present in West and East Africa as well as in Madagascar, while *O. schweinfurthiana* occurs in West Africa and *O. eichingeri* in East Africa. *O. punctata* could be studied only through its isotype obtained from the Central National Herbarium at Calcutta. Compared to *O. eichingeri* and *O. schweinfurthiana,* it is a smaller plant, but it has longer ligules, larger spikelets with longer awns. The panicles of *O. eichingeri* and *O. schweinfurthiana* are somewhat contracted with short ascending branches while in *O. punctata* they are lax with spreading branches. Thus *O. punctata* could be distinguished from the other two taxa by its panicle and spikelet characters as well as by the size of the ligule.

O. schweinfurthiana and *O. eichingeri* are very much similar in appearance to each other, but Chevalier (1932), Chatterjee (1948) and Tateoka (1963) have merged *O. schweinfurthiana* with *O. punctata*. Andrews (1956), however, listed *O. schweinfurthiana* as a separate species. Sampath (1963) is of opinion that the two taxa, *O. eichingeri* of East Africa and *O. schweinfurthiana* of West Africa, should be considered as one species till cytogenetic evidences prove otherwise. During this study two West African collections, one from Ghana and the other from Belgian Congo identified as *O. schweinfurthiana*, were grown and compared with *O. eichingeri* obtained from Tanganyika, East Africa, at the Indian Agricultural Research Institute, New Delhi, and at its Substation at Pusa. Bihar. They are very much similar in all morphological characters except in the size of spikelet. In order to study the cytogenetical differences, if any, of the two taxa, the two were crossed. The F_1 was found to be partially fertile with 45% spikelet-fertility. The meiosis in F_1 hybrid was normal with 24 bivalents being formed regularly, in most of the cells examined. Hence it is inferred that partial sterility is not due to any gross structural differences of chromosomes but it might either be caused as a result of accumulation of genic differences or due to cryptic structural changes. Therefore, on both morphological and cytogenetical considerations the West African and East African taxa are similar to each other. Morphologically they are more similar to each other than they are to *O. punctata*. The cytogenetic relationships between *O. punctata* on one hand and the other two tetraploid species on the other are yet to be studied.

The close morphological and cytogenetical similarities between *O. eichingeri* and *O. schweinfurthiana* do not warrant treating them as separate species and hence the two should be merged and listed as *O. schweinfurthiana*

invoking the principle of priority in botanical nomenclature (Chapter III, Sections 1 and 10 in *International Rules of Botanical Nomenclature*). However, partial sterility of their hybrids and slight morphological differences between the two taxa suggest that some isolating mechanisms have been developed between them and hence they do deserve subspecific rank. Accordingly, *O. schweinfurthiana* is now reclassified as *O. schweinfurthiana* subsp. *schweinfurthiana* Prod. and *O. eichingeri*, as *O. schweinfurthiana* subsp. *eichingeri* Peter.

Botany Division,   R. GOPALAKRISHNAN.*
Indian Agricultural
    Research Institute,
New Delhi-12, *June* 18, 1965.

* Present Address : Regional Rice Research, Station Trichur, Kerala, India.

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CYTOLOGICAL EFFECTS OF GIBBERELLIC ACID (GIBBERELLIN A₃) ON *DRAPARNALDIA PLUMOSA* (VAUCH.) AG.

PREVIOUS findings on the effects of gibberellins or gibberellin-like substances on algæ have gone to show that they involve nuclear division and cell extension, although no detailed studies about cytological facts have been made so far.

When *Draparnaldia plumosa* was grown in Godward's culture solution[1] containing different concentrations of GA, the authors noted the following as the main effects :

(1) retardation of the mitotic cycle under cultural conditions (12 hours light followed by 12 hours darkness in 24 hours);

(2) promotion of mitosis in continuous light ;

(3) occurrence of various abnormalities in mitosis such as "segmented chromosomes", anaphase bridge, tendency to c-mitosis and formation of polyploid and aneuploid nuclei.

All the above abnormalities disappeared on removal of the material from the GA to only Godward's culture solution.[1]

Some effects of a similar nature on higher plants have been reported by Kato[2] and Berger[3] but hitherto the induction of polyploidy through prevention of spindle formation as by colchicine has not been ascribed to GA ; although polyploidy associated with GA was found by Kato[2] and Berger.[3]

A detailed account of these results supported by photomicrographic evidences will be published soon.

Department of Botany,   A. ABBAS.
Aligarh Muslim University,
Aligarh,
              and
Department of Botany,   M. B. E. GODWARD
Queen Mary College,
University of London,
London-E. 1, *June* 17, 1965.

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ON THE OCCURRENCE OF ABNORMAL SYMPTOMS IN COVERED SMUT OF BARLEY CAUSED BY *USTILAGO HORDEI* (PERS.) LAGERH.

THIS is a record of some abnormal symptoms produced on barley by *Ustilago hordei* (Pers.) Lagerh. causing covered smut, a common disease in this part of the country. The specimens were collected in March 1960 from a barley field on Garh Road, Meerut.

Faris (1924) reported some cases where leaf tips of upper two or three leaves rarely showed smut pustules which extended to the leaf-sheaths and even to the nodes below. He observed such cases in the green-house conditions but in the field such cases were reported to be very rare.

The symptoms reported here are different from those reported by Faris. In addition to the usual symptoms already described by Butler (1918) and Butler and Jones (1949) the upper two or three leaves showed severe infection on the leaf-sheath and lamina. Black pustules ran parallel to the veins in streaks and resembled very much with the external symptoms of flag smut of wheat, caused by *Urocystis tritici* (Figs. 1, 2).

In these infected plants, the most remarkable feature is seen on two or three uppermost nodes below the smutted ear. These nodes become approximated or separated more or less. They

show considerable hypertrophy forming somewhat blackish thick annular ring surrounding the nodal region (Figs. 1, 2). These hyper-

FIGS 1–2. Fig. 1. Two smutted upper nodes of an infected plant placed apart. Fig. 2. Two smutted upper nodes of an infected plant much approximated.

trophied rings remain covered by their respective leaf-sheath bases which form a sort of pouch all round. Very often, the intervening internodes and the stalk of the infected ear may become somewhat twisted. These observations indicate that the extension of smutted pustules is from node to the leaf tip through the leaf-sheath and not in the reverse direction as reported by Faris (1924).

Hypertrophied ring on the node and the streaks of smutted pustules on the leaves are full of spores that are brownish-black in colour measuring as usual 5–9 microns in diameter. It has not been possible, however, at this stage to determine whether the severity of infection in such abnormal cases was due to more susceptible variety of barley or to the presence of a more virulent physiologic race of *U. hordei.*

I am much indebted to Prof. V. Puri for encouragement and suggestions and I thank Dr. R. Shiam for help in drawing the sketches.

School of Plant Morphology,   M. R. SHARMA.
Meerut College, Meerut, *May* 27, 1965.

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2. — and Jones, S. G., *Plant Pathology*, London, 1949.
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P-TOLUENE SULFONIC ACID AS A CHROMOGENIC REAGENT FOR LOCATION OF INDOLE DERIVATIVES ON PAPER CHROMATOGRAMS

WHILE studying the nature of leucoanthocyanins of cabbage, it was noticed that the ethyl acetate extracts of cabbage gave spots of high Rf value on paper chromatograms in butanol-acetic acid-water system turning to rose pink when treated with an alcoholic solution of P-toluene sulfonic acid in the cold.[1] These spots which also reacted with Ehrlich's reagent were later found to be indole acetic acid, indole-3-aldehyde and indole acetonitrile. Incidentally leucoanthocyanins were not traced in the cabbage extracts. The rose pink colour on paper chromatogram appears in the cold within 10–15 minutes after spraying the reagent and the time could be reduced to 1-2 minutes by heating the chromatogram. The colour is stable for over 6-8 hours without any marked change in intensity. The colour formation is inhibited in the presence of alcohol and water. The mechanism of the reaction is not known.

Of the indole compounds tested, indole (1 μg.), indole acetic acid (1 μg.), indole acetonitrile and indole-3-aldehyde reacted with the reagent to give rose pink colour. Tryptophan, indole butyric acid, indole propionic acid and skatole gave only grey colour. Thus the use of p-toluene sulfonic acid to differentiate some of the indole derivaties has been indicated.

The author's thanks are due to Sri. V. S. Govindarajan for useful discussions.

Central Food Technological   J. V. PRABHAKAR.
   Research Institute,
Mysore, *September* 7, 1965.

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REVIEWS AND NOTICES OF BOOKS

Developments in Applied Spectroscopy (Vol. 4). Edited by Elwin N. Davis. (Plenum Press, 227, W. 17th St., New York, N.Y. 10011), 1965. Pp. xi + 546. Price $ 18.50.

This volume represents the Proceedings of the Fifteenth Annual Mid-America Spectroscopy Symposium, held from 2nd June to 5th June, 1964, in Chicago, Illinois, sponsored by the Society for Applied Spectroscopy, Chicago Section. It contains 45 of the papers read at the meeting in the following subject areas : X-Ray Spectroscopy (9 papers); Infrared and Raman Spectroscopy (8 papers); Ultraviolet and Visible Spectroscopy (4 papers); Gas Chromatography (11 papers); NMR, Emission, Flame, and Atomic Absorption Spectroscopy (13 papers).

In addition to serving as a permanent record of the majority of symposia presentations, this volume, like its predecessors, will prove to be stimulating reading for scientists concerned with instrumental methods of chemical analysis. The techniques and applications set forth in the various papers are intended to serve as a basis for problem solving and future developments in similar areas of chemical research and analysis.   C. V. R.

Documents on Modern Physics. Edited by Elliott W. Montroll. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-1, N.Y.).

This is a new series published in inexpensive paperback and clothbound editions which make available selected surveys, lecture notes, conference proceedings, and important collections of research papers in branches of physics of special current interest.

   1. *Lectures on Magnetoionic Theory.* By K. G. Budden, 1964. Pp. 82. Price : Paper $ 1.95 ; Cloth $ 3.95.

The articles contained in this book are as follows : 1. Foundations ; 2. Rays and Wave Packets ; 3. Impulses and Dispersion ; 4. Wave Admittance and Impedance ; 5. Some Notes on the Phase Integral Method.

   2. *L'effet Mossbauer et Ses Applications a L'etude Des Champs Internes.* By A. Abragam, 1964. Pp. 70. Price : Paper $ 1.95 ; Cloth $ 3.95.

The articles contained in this book are as follows : 1. L'effet Mossbauer ; 2. Theorie de

L'effet Mossbauer ; 3. L'effet des Ultrasons ; 4. Application de L'Effet Mossbauer a L'Etude des Structures Hyperfines ; 5. Bref Rappel de Quelques Proprietes du Rayonnement γ ; Le Fer ^{57}Fe ; 7. L'Effet Mossbauer dans L'Etain ^{119}Sn.

   3. *Theory of Crystal Dislocations.* By A. H. Cottrell, 1964. Pp. ix + 91. Price : Paper $ 2.50 ; Cloth $ 4.50.

The articles contained in this book are as follows : 1. Dislocation and Slip ; 2. Geometrical Properties of Dislocations ; 3. Geometry of Dislocated Crystals ; 4. The Elastic Field of a Dislocation ; 5. Dynamics of Moving Dislocations ; 6. Forces on Dislocations ; 7. Structure of the Centre of a Dislocation ; 8. Imperfect Dislocations ; 9. Dislocations and the Properties of Crystals.   C. V. R.

Progress in Astronautics and Rocketry. (Academic Press, New York and London) :

   1. Volume 8— *Guidance and Control.* Edited by Robert E. Roberson and James S. Farrior, 1962. Pp. xv + 670. Price $ 9.25.

   2. Volume 11—*Power Systems for Space Flight.* Edited by Morris A. Zipkin and Russell N. Edwards, 1963. Pp. xvi + 943. Price $ 13.50.

   3. Volume 13—*Guidance and Control—II.* Edited by Robert C. Langford and Charles J. Mundo, 1964. Pp. xv + 997. Price $ 14.25 ; Reg. $ 10.75. A.I.A.A. mem.

Volume 8 contains a selection of technical papers based mainly on a Symposium of the American Rocket Society held at Stanford University, Stanford, California, August 7-9, 1961. The papers are grouped under the following eight heads and the number of papers under each head is shown against each : A. Ascent : Three ; B. Space Operations : Five ; C. Descent : Three ; D. Inertial Navigation : Four ; E. Inertial Components : Four ; F. Optical Navigation : Three ; G. Adaptive Systems : Two ; and H. Attitude Control : Five.

Volume 11 contains a selection of technical papers based mainly on the American Rocket Society Space Power Systems Conference held at Santa Monica, California, September 25-28, 1962. The papers are grouped under the following five heads and the number of papers under each head is shown against each : A. Selection

is assumed, although the material is generally at an introductory level.

There is a repeated emphasis on the systematic statement of algorithms in terms of array elements and subscript variables. Programming language is introduced early in the course so that students will be able to start on assigned problems. Because the vast majority of programmers use a statement-type language, this type of programming is emphasized. This permits the consideration of algorithms more complicated than a machine language would allow.

The Turing machine, which can be regarded either as a machine or a language, provides a natural point of departure for the description of an actual machine. Several analytic topics and simplest proofs are included to illustrate the analytic basis of numerical methods.

C. V. R.

The Photochemical Origin of Life. By A. Dauvillier. (Academic Press, New York and London), 1965. Pp. ix + 193. Price $ 7.50.

The theory of the author given in this volume explains the origin of life as an interdisciplinary problem of cosmic physics involving astronomy, geophysics, and geochemistry. He shows that cosmic paleovulcanism played an important role by bringing about the pyrogenetic synthesis of numerous heterocyclic compounds; after condensation of the oceans, photochemical reactions occurred that were capable of creating the optical rotation characteristic of living matter.

Topics discussed in this volume include: characteristics of living matter; theories of the origin of life; cosmogony and geogeny: the origin of the earth; the origin of the continents, oceans, and atmospheres; the photochemical synthesis of organic matter; the organization of living matter; the evolution of living creatures; the energetics of the biosphere; the geochemical role of the biosphere; life in the universe.

C. V. R.

Advances in Pharmaceutical Sciences (Vol. I). Edited by H. S. Bean, A. H. Becket and J. E. Carless. (Academic Press, London and New York), 1964. Pp. xi+334. Price 75 sh.

The aim of this series is to inform on significant developments in specialized areas, particularly within the field of pharmaceutics, but from time to time in associated disciplines. The subject-matter in this volume is dealt with in four sections by the respective authors shown against each. 1. Rheology, by Alfred N. Martin,

Gilbert S. Banker and A. H. C. Chun; 2. Solubility in Systems Containing Surface-Active Agents, by B. A. Mulley; 3. Preservation of Emulsions against Microbial Attack, by Dorren L. Wedderburn; and 4. Contemporary Trends in Heat Sterilization, by G. R. Wilkinson and L. C. Baker. The number of articles under each section are three, eight, eight and thirty-four respectively.

C. V. R.

Focus on Bacteria. By E. Kleineberger-Nobel. (Academic Press, New York and London), 1965. Pp. vii + 145. Price 32 sh. 6 d.

This richly illustrated book is intended for the layman with keen scientific interest and some fundamental knowledge of the sciences and of biology in particluar. It supplies the reader with information on the structure of bacteria, their activities, their viruses and their genetics, without going into the details. The text is supplemented by a glossary of terms and by many simple line drawings of an explanatory nature. For those who intend to take up the study of this branch of biology, it will prove useful as an introduction to bacteriology.

C. V. R.

Advances in Metabolic Disorders (Vol. 1). Edited by Rachmiel Levine and Rolf Luft. (Academic Press, New York and London), 1964. Pp. xii + 366. Price 86 sh.

This new international serial publication will enable physicians, investigators, and graduate students to keep abreast of the rapid progress concerning metabolic processes in the body and their connections with the disorders of metabolism.

The chapter headings and their respective authors contained in this volume are as follows: Glycogen Storage Disease, by H. G. Hers; The Parathyroids, by G. D. Aurbach and John T. Potts, Jr.; Mitochondrial Respiratory Control: Biochemical, Physiological and Pathological Aspects, by Lars Ernster and Rold Luft; Osteoporosis, by B. E. C. Nordin; Basal Metabolic Rate and Thyroid Hormones, by J. R. Tata; Insulin Antagonists and Inhibitors, by J. Vallance-Owen; Aldosterone: Its Biochemistry and Physiology, by John H. Laragh and William G. Kelly; Folic Acid Deficiency in Man and Its Interrelationship with Vitamin B_{12} Metabolism, by A. Leonard Luhby and Jack M. Cooperman.

C. V. R.

Craigie's Neuroanatomy of the Rats. Revised and Expanded by Wolfgang Zeman and James Robert Maitland Inees. (Academic Press, New York and London), 1963. Pp. ix + 230. Price $ 8.50.

This new edition will be of value to students and research workers in a variety of fields. Pathologists, for example, will use the plates to determine the localization of brain lesions induced through exposure of rats and mice to infections, malnutrition, and toxic chemical substances. Those engaged in experimental neurophysiology, ablation studies, usage of the sterotaxic instrument, and studies of animal behavior will find the book indispensable. For the physiological toxicologist, and experimental pharmacologist, and pathologist it offers a means for the rapid identification of discrete and well-defined anatomical landmarks of a rat's central nervous system. Students of zoology, medicine, and veterinary medicine will find it an excellent introduction to neuroanatomy.

C. V. R.

The Epidermis. Edited by William Montagna and Walter C. Lobitz, Jr. (Academic Press, New York and London), 1964. Pp. xx + 649. Price $15.00.

This volume is a source book of basic dermatologic thought and information. More than a book of dermatology, this volume makes a singular contribution to our knowledge of keratinication.

Unique features of the book are : the developmental sequences and enzymic properties of the epidermis, protein synthesis, and the nature of the proteins are elucidated ; a thorough treatment is given to the ultrastructure of the epidermis in normal and pathologic states, particularly as it relates to the integrity of the tissue and to the formation of keratin ; there is greater emphasis in functional ultrastructure than there has ever been before ; the metabolic properties of the epidermis are explored in detail and a complete coverage is given to the structure and chemical composition of keratin.

C. V. R.

Newer Methods of Preparative Organic Chemistry (Vol. III). Edited by Wilhelm Foerst. Translated by Henry Birnbaum. (Academic Press, Inc., New York and London), 1964. Pp. 544. Price 114 *sh.* 6 *d.*

The object of this series is to provide the English-speaking chemists with the review literature in German on recent developments in the methods of preparatory organic chemistry. This volume contains eleven articles on different topics originally published in *Angewandte Chemie.* The summaries of the methods given are exhaustive and authoritative. They give detailed experimental directions, and the probable reaction mechanisms are also discussed. References to original literature abound.

The main contents are as follows : Introduction of substitution into the pyridine ring ; Reactions of sulphur with araliphatic and aliphatic compounds ; The acyllactone rearrangement ; Organic syntheses using chloramine ; Aromatic compounds from pyrylium salts ; The formation of acetylenic bond ; Syntheses using diazoketones ; Preparation of esters, amides, and anhydrides of phosphoric acid.

This series of volumes should be of great value to all organic chemists both in academic institutions and industrial laboratories who wish to keep abreast of modern developments and techniques in preparative organic chemistry.

A. S. G.

Books Received

Potato in India—Varieties. By Pushkarnath. (Indian Council of Agricultural Research, Rajendra Prasad Road, New Delhi), 1964. Pp. 466. Price Rs. 25·00.

Organic Chemistry (Translated from Russian). By B. Pavlov and A. Terentyev (Gordon & Breach, Science Publishers, New York-11), 1965. Pp. 568. Price $16.00.

Engineering Physical Metallurgy (Translated from Russian). By Y. Lakhtin. (Gordon & Breach, Science Publishers, New York-11). 1965. Pp. 471. Price $14.50.

General Chemistry (Translated from Russian). By N. Glinka (Gordon and Breach, Science Publishers, New York-11, N.Y.). Pp. 694. Price $17.50.

Deranged Memory a Psychonomic Study of the Amnesic Syndrome. By G. A. Talland. (Academic Press, New York-10003), 1965. Pp. xi + 356. Price $9.50.

Handbook of Mathematical Functions. Edited by M. Abromowitz and I. A. Stegun. (Dover Publications Inc., New York-14), 1965. Pp. xiv + 1045. Price $4.00.

Advances in Agricultural Sciences and Their Applications. Edited by S. Krishnamurthi. (The Madras Agricultural Journal, Coimbatore-3), 1965. Pp. xiv + 666.

of Power Systems : Five ; B. Chemical Power Systems : Eleven ; C. Solar Power Systems : Six : D. Heat Transfer, Storage, and Rejection : Eleven ; E. High-Temperature Power Systems : Twelve.

Volume 13 contains a selection of technical papers based mainly on the American Institute of Aeronautics and Astronautics Guidance and Control Conference held at Cambridge, Massachusetts, August 12-14, 1963. The papers are grouped under the following seven heads and the number of papers under each head is shown against each : I. Active and Passive Attitude Control for Space Vehicles : Eleven ; II. Inertial Guidance for Space Flight : Five ; III. Onboard Techniques for Interplanetary Flight : Four ; IV. Manned Control of Space Vehicles : Three ; V. Deep Space Guidance and Navigation : Five ; VI. Rendezvous : Five ; VII. Re-entry and Landing : Three.   C. V. R.

Advances in Inorganic Chemistry and Radiochemistry (Vol. 6). (Academic Press, New York and London), 1964. Pp. ix + 530. Price $ 16.00.

Volume 6 of this well-known series contains the following eight important articles and the names of their respective authors are shown against each : 1. Complexes of the Transition Metals with Phosphines, Arsines, and Stibines, by G. Booth ; 2. Anhydrous Metal Nitrates, by C. C. Addison and N. Logan ; 3. Chemical Reactions in Electric Discharges, by Adli S. Kana'an and John L. Margrave ; 4. The Chemistry of Astatine, by A. H. W. Aten, Jr.; 5. The Chemistry of Silicon-Nitrogen Compounds, by U. Wannagat ; 6. Peroxy Compounds of Transition Metals, by J. A. Connor and E. A. V. Ebsworth ; 7. The Direct Synthesis of Organosilicon Compounds, by J. J. Zuckerman ; and 8. The Mossbauer Effect and Its Application in Chemistry, by E. Fluck.   C. V. R.

Advances in Organometallic Chemistry (Vol. 2). By F. G. A. Stone and Robert West. (Academic Press, New York and London), 1965. Pp. ix + 440. Price $ 15.00.

This series publishes authoritative reviews on recent developments in all aspects of the chemistry of metal-carbon compounds : structural, theoretical, synthetic, and technological.

The book contains the following seven contributions by the authors whose names are shown against each : 1. Some Advances in the Organometallic Chemistry of Nickel, by G. N. Schrauzer : 2. The Strengths of Metal-to-Carbon

Bonds, by H. A. Skinner ; 3. Electronic Structure of Alkali Metal Adducts of Aromatic Hydrocarbons, by E. De Boer ; 4. Reactions of Alkali Metal Derivatives of Metal Carbonyls and Related Compounds, by R. B. King ; 5. Heterocyclic Organoboranes, by R. Koster ; 6. Allyl Metal Complexes, by M. L. H. Green and P. L. I. Nagy ; and 7. Synthesis of Cyclopentadienyl Metal Compounds, by John Birmingham.

Teachers or those who are engaged in chemical research, chemical engineers and industrial chemists associated with petroleum and polymer industries, and students in chemistry and related fields will find this volume to be of real value.
      C. V. R.

Computing Methods in Optimization Problems. Edited by A. V. Balakrishnan and L. W. Neustadt. (Academic Press, New York and London), 1964. Pp. x + 327. Price $ 7.50.

The Conference at Los Angeles on computing methods in optimization problems was organized to provide a forum for the dissemination of recent research progress in the area and to share computing experience gained in specific large-scale problems.

This book is based on the papers presented at the Conference. Topics of study include—hybrid computing methods ; variational theory and optimal control theory ; dynamic programming, invariant imbedding and quasilinearization ; and a comparison between some methods for computing optimum paths in the problem of Bolza.   C. V. R.

Annual Review of Biochemistry (Vol. 34). Edited by P. D. Boyer and J. M. Luck (Annual Reviews, Inc., 231, Grant Avenue, Palo Alto; California, U.S.A.), 1965. Pp. vii + 700. Price $ 8.50 (U.S.A.) ; $ 9.00 (elsewhere).

Volume 34 of this well-known series contains the following chapters : Chemist, Biochemist, and Seeker in Three Countries, by (Max) Rudolf Lemberg ; Oxidases, by H. S. Mason : Energy-Linked Reactions in Mitochondria, by D. Rao Sanadi ; Mechanism of Action of Proteolytic Enzymes, by Myron L. Bender and Ferenc J. Kezdy ; Enzymatic Mechanisms in Steroid Biochemistry, by Paul Talalay ; Carbohydrates—Mono- and Oligosaccharides, by S. J. Angyal and D. Rutherford ; Prostaglandins, by Sune Bergstrom and Bengt Samuelsson ; Glycolipids, by Herbert E. Carter, Peter Johnson, and Evelyn J. Weber ; Chemistry and Function of Amino Sugars and Derivatives, by M. R. J. Salton ; The Chemistry and Structure of

Peptides and Proteins, by B. Keil; The Basic Proteins of Cell Nuclei, by K. Murray; Structural Studies with X-Rays, by Joseph Kraut; Photosynthesis, by Leo P. Vernon and Mordhay Avron; Carbohydrate Metabolism, by Elizabeth F. Neufeld and Victor Ginsburg; Lipid Metabolism, by William E. M. Lands; Amino-Acid Metabolism, by Mary Ellen Jones; Nucleic Acids and Protein Biosynthesis, by Kivie Moldave; Metabolism of Nucleic Acids (Macromolecular DNA and RNA), by David Elson; The Biochemistry of Virus Replication, by Leon Levintow; Biochemical Aspects of Genetics, by N. H. Horowitz and Robert L. Metzenberg; The Chemistry of Differentiation in Lower Organisms, by Helen H. Baldwin and Harold P. Rusch.   C. V. R.

Dynamic Programming in Chemical Engineering and Process Control, Volume 12: *Mathematics in Science and Engineering.* Series Editor: Richard Bellman; Author: Sanford M. Roberts. (Academic Press, New York and London), 1964. Pp. xiii + 457. Price $ 14.50.

This book elucidates the intermediate steps between dynamic programming as a mathematical discipline and its use as an engineering tool. The titles of the nine chapters into which the book is divided are listed below: 1. Introduction; 2. Replacement Problems; 3. Allocation Problems; 4. Dynamic Programming and the Calculus of Variations; 5. Computational Aspects of Dyanmic Programming; 6. Control Problems; 7. Chemical Engineering Control Problems; 8. Inventory Problems; and 9. Stochastic Processes. The book, while slanted for the chemical engineer and process engineer, is a useful tool for all who deal with multi-stage decision processes, whether through time or sequence.   C. V. R.

Advances in Computers. Edited by Franz L. Alt and Morris Rubinoff. (Academic Press, New York and London):

Volume 4, 1963. Pp. xii + 312. Price $ 12.00.

Volume 5, 1964. Pp xiii + 397. Price $ 14.00.

Advances in Computers brings together articles concerned with the design and operation of computing systems and their components. The volumes include articles on methods of machine programming and numerical analysis as well as on computer applications to scientific problems, engineering problems, business management, data processing, statistics, control of operations, and "pseduological" problems.

Volume 4 of the series contains the following five articles|: The Formulation of Data Processing Problems for Computers, by William C. McGee; All-Magnetic Circuit Techniques, by David R. Bennion and Hewitt D. Crane; Computer Education, by Howard E. Tompkins; Digital Fluid Logic Elements, by H. H. Glaettli; Multiple Computer Systems, by William A. Curtin.

Volume 5 of the series contains the following seven articles: The Role of Computers in Election Night Broadcasting, by Jack Moshman; Some Results of Research on Automatic Programming in Eastern Europe, by Wladyslaw Turski; A Discussion of Artificial Intelligence and Self-Organization, by Gordon Pask; Automatic Optical Design, by Orestes N. Stavroudis; Computing Problems and Methods in X-Ray Crystallography, by Charles L. Coulter; Digital Computers in Nuclear Reactor Design, by Elizabeth Cuthill; An Introduction to Procedure-Oriented Languages, by Harry D. Huskey.

These volumes will be found to be of great value by computer mathematicians, computer engineers and users.   C. V. R.

Applied Geochronology. By E. Hamilton. (Academic Press, New York and London), 1965. Pp. vi + 267. Price 59 *sh.*

The dating of rocks and related isotope studies have become increasingly important branches of the Earth Sciences. A large gap now exists between those who obtain and interpret results, and the field geologist who wishes to apply these results to conventional geological problems. This book now fills the gap. For a fuller appreciation of results the principles of the physical and chemical methods are described in some detail. The results are interpreted in terms of various problems encountered by the geologist in routine field studies. Apart from dating the age of rocks and minerals, related isotope studies can, in many cases, be applied to fundamental problems of petrology and geophysics. This volume, though meant for geologists, will also be found useful by persons interested in the general field of the Earth Sciences.   C. V. R.

An Introduction to Digital Computing. By Professor Bruce W. Arden. (Addison-Wesley Publishing Co., Inc., U.S.A. and London), 1963. Pp. ix + 389. Price $ 6.50.

This text is designed for an introductory course in computing techniques at the undergraduate level. A knowledge of integral calculus

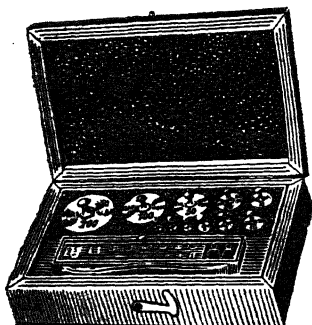climatological patterns, it has hitherto been the practice to have intensive study during the south-west monsoon season of the conditions at the surface, 900, 850, 700, 600 and 500 mb. particularly, although during the last decade or so study of circulation at levels above 500 mb. is also being made.

Although plenty of information is available for the Indian subcontinent and neighbouring land areas, for the surface and upper air conditions on which the existing ideas of the mechanism of south-west monsoon are based, there has been very inadequate knowledge of the actual conditions over the seas except at the surface. As a result the International Indian Ocean Expedition (IIOE) was organised and very valuable data over the Indian seas have been collected during 1963 and 1964. A preliminary presentation of some of the data was made in a seminar held at Bombay on 1st August 1963 ; a fuller presentation of the data was made during the symposium at Bombay from 22nd-26th July, 1965 by various workers of the International Meteorological Centre at Bombay and by others who took part in the Expedition as also by some workers at Poona and other offices of the Indian Meteorological Department. The results of the IIOE presented by them can be summarised as under :

(*i*) Equator : To the west of Long. 50° E., there is moist unstable layer upto about 900 mb. and presence of an inversion or isothermal layer between about 850 and 800 mb. and of relatively drier unstable layer upto about 600 mb. ; decrease of moisture is rapid above 900 mb.

At Gan (Long. 73° E.) near the equator (basis July mean) there was rather unstable lapse upto about 850 mb. and more stable lapse above upto 500 mb. level, and no inversion or isothermal layer ; moisture continuously decreases with height, but it was more at all levels than at places on the equator west of Long. 50° E.

(*ii*) Arabian Sea west of Long. about 70° E. : Conditions were more or less similar to those at the equator west of Long. 50° E. except for the fact that there is relatively more moisture in the levels upto about 900 mb. in the central Arabian Sea ; the height of base of inversion is about 1 km. off Sind coast and in the west Arabian Sea west of about Long. 60° E.

There is no appreciable change in the moisture content between about Lats. 5° and 20° N. and Longs. 50° and 70° E. between about 900 and 700 mb.

There is practically no convective cloud or middle or high cloud but there is a to overcast layer of low stratocumulus. practically no rain.

(*iii*) Arabian Sea east of Long. 70 south of Lat. 20° N. : As one approach the height of the base of inversion and its thickness decreases, the inver appearing over Bombay, where there w siderable increase in moisture at all lev compared with places to the west durin monsoon.

Weather and cloudiness increase coast, there being presence of lai towering Cu and Cb clouds above low stratus sheet and precipitation within 300 miles of the coast, the effect being in at and near the Western Ghats.

(*iv*) At Bombay, Minicoy and Gan Long. 73° E.) there was in the mean no inversion ; temperature and moistu 1° to 3° C. and 1 to 3 gm./kg. higher resp at Bombay than over Minicoy which has temperature about 1° C. higher and 1 to 3 gm./kg. more than at Gan.

(*v*) Of the air masses present, the air is the coldest at the surface.

(*vi*) There is presence of a trough the south of equator between about 1 and 110° E. Westerlies extend upto 500 mb. near the equator.

(*vii*) Inversions are practically abs the Bay of Bengal during active monsoon.

(*viii*) There is presence of a jet m speed of 25 m./sec. between Long. 53 height of about 560 metres and Long at a height of about 1,000 metre magnitude of the jet decreases eastward only about 15 m./sec. near India.

There is no jet north of Lat. 20° N. at Lat. 4° N.

From what has been stated above it that the IIOE expedition results ov Arabian Sea bring out very clearly that the months June to September, there homogeneous monsoon current of 4 t thickness over the Arabian Sea off th coast of the Peninsula as hitherto con there is a peculiar air mass stratification moist (upto about 850 mb.) and upp unstable air masses with an inversion b the two, there being no convective clou rain west of about Long. 70° E. These would require modification in the mechanism of south-west monsoon as understood by the Indian Meteorologist

The results of the IIOE expedition hav discussed by the workers referred to ca

the papers presented by them at the Bombay seminar in 1963 and symposium in 1965 and they have put forward their views regarding the mechanism of south-west monsoon—little or no rain over west and north Arabian Sea and over Sind and neighbourhood due to subsidence (presence of inversion) over the areas preventing formation of convective clouds and rain and (ii) over the west coast of the Peninsula, particularly in the northern portion and upto Kutch, rain occurs due to a quasi-stationary mid-tropospheric depression which develops, intensifies and dissipates over a period of two to three weeks in the vicinity of Bombay and whose origins are usually obscure. There was no attempt by any worker to modify the hitherto accepted theories of the south-west monsoon in the light of the IIOE results and one actually got an impression that according to them the existing ideas required a radical revision.

It may be mentioned that more than 40 papers were presented in the symposium in the four days and there was little time (in all about a total of four hours) for fruitful discussion of the interpretations put forward. As such the Indian Meteorologists present had no opportunity to present a revised mechanism of the south-west monsoon reconciling the new important facts of observations over the seas during IIOE period. From the interpretations of the results presented during the symposium one cannot help getting an impression that much more attention needs to be paid to (i) the facts of weather and climatology during the south-west monsoon season and (ii) the orographic features of the Indian subcontinent. The reviewer proposes in the light of his experience of over twenty years in day-to-day forecasting of weather to interpret in due course the IIOE results modifying the hitherto accepted mechanism of south-west monsoon only to a small extent in so far as the effect of the Western Ghats is concerned to destroy the inversion and produce a more or less homogeneous air mass in the first 5 km. above the surface over the Peninsula.

1. Simpson, G. C., *Q. J Roy. Met. Soc.*, 1921, 47 (199), 152.

2. Petterssen, S, *Proc. Ind. Acad Sci.*, 1953, **37 A**, 229.

3. *Climatological Charts for Airmen*, I. Met. D., 1943.

4. *Climatological Charts for the Indian Monsoon Area*, I. Met. D., 1945.

5. Ramakrishnan, K. P., *et al.*, *Monsoons of the World* 19-21 Feb. 1958, New Delhi.

BIOGEOGRAPHY AND ECOLOGY IN ANTARCTICA *

ANTARCTICA has become a gigantic laboratory and research field, thanks to the International Geophysical Year, and it has been recognized so by the Antarctic Treaty signed in 1959 by the twelve nations which participated in the IGY Antarctic expeditions. The treaty guarantees freedom of scientific research in this vast territory for a period of thirty years, and the members have enjoined to use it only for peaceful purposes.

Most of the Antarctic mainland is an ice desert with the thickness of ice varying from 2,000 to 4,000 metres. As part of their programme for the IGY the twelve nations established permanent or semi-permanent bases on the Antarctic continent or on sub-Antarctic islands and collected a vast amount of scientific data in different fields of study. The book under review gives a general survey of what had been done by them in the way of biogeographical and ecological research. The Editors were actively concerned with the international scientific activities in the Antarctic, and with the co-operation of a team of internationally reputed authors they have brought out a volume of great utility which not only sums up the present state of knowledge in the subjects of the title but also points the way to future planned investigations in the Antarctica.

The book is in two main parts. The first part of three chapters gives a detailed description of the different aspects of the environment including the geology and morphology, the climatology and the oceanography of the regions. The second part of fifteen chapters is devoted to the discussion of some of the main plant micro-organisms and animal groups of these regions. The subjects dealt with are Algæ, Lichens, Vascular plants, Crustacea, Mollusca, Copepoda, Bryozoa. There are chapters on Acarology, Land arthropods, Fish fauna and Birds of Antarctica. A long article, in French, is the one on the "Ecology of Antarctic Penguins", which is illustrated by 24 plates. The book concludes with an interesting chapter on Human adaptation to life in Antarctica.

The book is an example of the significant fact that international co-operation can achieve a lot in the way of scientific advancement,

of Power Systems : Five ; B. Chemical Power Systems : Eleven ; C. Solar Power Systems : Six ; D. Heat Transfer, Storage, and Rejection : Eleven ; E. High-Temperature Power Systems : Twelve.

Volume 13 contains a selection of technical papers based mainly on the American Institute of Aeronautics and Astronautics Guidance and Control Conference held at Cambridge, Massachusetts, August 12-14, 1963. The papers are grouped under the following seven heads and the number of papers under each head is shown against each : I. Active and Passive Attitude Control for Space Vehicles : Eleven ; II. Inertial Guidance for Space Flight : Five ; III. Onboard Techniques for Interplanetary Flight : Four ; IV. Manned Control of Space Vehicles : Three ; V. Deep Space Guidance and Navigation : Five ; VI. Rendezvous : Five ; VII. Re-entry and Landing : Three. C. V. R.

Advances in Inorganic Chemistry and Radio-chemistry (Vol. 6). (Academic Press, New York and London), 1964. Pp. ix + 530. Price $ 16.00.

Volume 6 of this well-known series contains the following eight important articles and the names of their respective authors are shown against each : 1. Complexes of the Transition Metals with Phosphines, Arsines, and Stibines, by G. Booth ; 2. Anhydrous Metal Nitrates, by C. C. Addison and N. Logan ; 3. Chemical Reactions in Electric Discharges, by Adli S. Kana'an and John L. Margrave ; 4. The Chemistry of Astatine, by A. H. W. Aten, Jr.; 5. The Chemistry of Silicon-Nitrogen Compounds, by U. Wannagat ; 6. Peroxy Compounds of Transition Metals, by J. A. Connor and E. A. V. Ebsworth ; 7. The Direct Synthesis of Organosilicon Compounds, by J. J. Zuckerman ; and 8. The Mossbauer Effect and Its Application in Chemistry, by E. Fluck. C. V. R.

Advances in Organometallic Chemistry (Vol. 2). By F. G. A. Stone and Robert West. (Academic Press, New York and London), 1965. Pp. ix + 440. Price $ 15.00.

This series publishes authoritative reviews on recent developments in all aspects of the chemistry of metal-carbon compounds : structural, theoretical, synthetic, and technological. The book contains the following seven contributions by the authors whose names are shown against each : 1. Some Advances in the Organometallic Chemistry of Nickel, by G. N. Schrauzer ; 2. The Strengths of Metal-to-Carbon

Bonds, by H. A. Skinner ; 3. Electronic Structure of Alkali Metal Adducts of Aromatic Hydrocarbons, by E. De Boer ; 4. Reactions of Alkali Metal Derivatives of Metal Carbonyls and Related Compounds, by R. B. King ; 5. Heterocyclic Organoboranes, by R. Koster ; 6. Allyl Metal Complexes, by M. L. H. Green and P. L. I. Nagy ; and 7. Synthesis of Cyclopentadienyl Metal Compounds, by John Birmingham.

Teachers or those who are engaged in chemical research, chemical engineers and industrial chemists associated with petroleum and polymer industries, and students in chemistry and related fields will find this volume to be of real value. C. V. R.

Computing Methods in Optimization Problems. Edited by A. V. Balakrishnan and L. W. Neustadt. (Academic Press, New York and London), 1964. Pp. x + 327. Price $ 7.50.

The Conference at Los Angeles on computing methods in optimization problems was organized to provide a forum for the dissemination of recent research progress in the area and to share computing experience gained in specific large-scale problems.

This book is based on the papers presented at the Conference. Topics of study include— hybrid computing methods ; variational theory and optimal control theory ; dynamic programming, invariant imbedding and quasilinearization ; and a comparison between some methods for computing optimum paths in the problem of Bolza. C. V. R.

Annual Review of Biochemistry (Vol. 34). Edited by P. D. Boyer and J. M. Luck (Annual Reviews, Inc., 231, Grant Avenue, Palo Alto; California, U.S.A.), 1965. Pp. vii + 700. Price $ 8.50 (U.S.A.) ; $ 9.00 (elsewhere).

Volume 34 of this well-known series contains the following chapters : Chemist, Biochemist, and Seeker in Three Countries, by (Max) Rudolf Lemberg ; Oxidases, by H. S. Mason ; Energy-Linked Reactions in Mitochondria, by D. Rao Sanadi ; Mechanism of Action of Proteolytic Enzymes, by Myron L. Bender and Ferenc J. Kezdy ; Enzymatic Mechanisms in Steroid Biochemistry, by Paul Talalay ; Carbohydrates—Mono- and Oligosaccharides, by S. J. Angyal and D. Rutherford ; Prostaglandins, by Sune Bergstrom and Bengt Samuelsson ; Glycolipids, by Herbert E. Carter, Peter Johnson, and Evelyn J. Weber ; Chemistry and Function of Amino Sugars and Derivatives, by M. R. J. Salton ; The Chemistry and Structure of

Proteins, by B. Keil ; The Basic
:ll Nuclei, by K. Murray ; Struc-
with X-Rays, by Joseph Kraut ;
, by Leo P. Vernon and Mordhay
1ydrate Metabolism, by Elizabeth
d Victor Ginsburg ; Lipid Meta-
lliam E. M. Lands ; Amino-Acid
· Mary Ellen Jones ; Nucleic Acids
3iosynthesis, by Kivie Moldave ;
Nucleic Acids (Macromolecular
A), by David Elson ; The Bio-
'irus Replication, by Leon Levin-
1ical Aspects of Genetics, by
itz and Robert L. Metzenberg ;
y of Differentiation in Lower
Helen H. Baldwin and Harold
C. V. R.

:amming in Chemical Engineering
. Control, Volume 12 : *Mathe-
cience and Engineering.* Series
1ard Bellman ; Author : Sanford
(Academic Press, New York and
34. Pp. xiii + 457. Price $ 14.50.

:lucidates the intermediate steps
1ic programming as a mathemati-
.nd its use as an engineering tool.
he nine chapters into which the
d are listed below : 1. Introduc-
.cement Problems ; 3. Allocation
Dynamic Programming and the
:iations ; 5. Computational Aspects
ogramming ; 6. Control Problems ;
Engineering Control Problems ;
'roblems ; and 9. Stochastic Pro-
ok, while slanted for the chemical
process engineer, is a useful tool
al with multi-stage decision pro-
r through time or sequence.
C. V. R.

Computers. Edited by Franz
Iorris Rubinoff. (Academic Press,
nd London):
963. Pp. xii + 312. Price $ 12.00.
964. Pp xiii + 397. Price $ 14.00.
Computers brings together articles
the design and operation of com-
s and their components. The
e articles on methods of machine
and numerical analysis as well
r applications to scientific prob-
ing problems, business manage-
rocessing, statistics, control of
1 "pseduological" problems.

Volume 4 of the series contains the following
five articles|: The Formulation of Data Process-
ing Problems for Computers, by William
C. McGee ; All-Magnetic Circuit Techniques,
by David R. Bennion and Hewitt D. Crane ;
Computer Education, by Howard E. Tompkins ;
Digital Fluid Logic Elements, by H. H. Glaettli ;
Multiple Computer Systems, by William
A. Curtin.

Volume 5 of the series contains the following
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Election Night Broadcasting, by Jack Moshman ;
Some Results of Research on Automatic Pro-
gramming in Eastern Europe, by Wladyslaw
Turski ; A Discussion of Artificial Intelligence
and Self-Organization, by Gordon Pask ; Auto-
matic Optical Design, by Orestes N. Stavroudis ;
Computing Problems and Methods in X-Ray
Crystallography, by Charles L. Coulter ; Digital
Computers in Nuclear Reactor Design, by
Elizabeth Cuthill ; An Introduction to Procedure-
Oriented Languages, by Harry D. Huskey.

These volumes will be found to be of great
value by computer mathematicians, computer
engineers and users. C. V. R.

Applied Geochronology. By E. Hamilton.
(Academic Press, New York and London),
1965. Pp. vi + 267. Price 59 *sh.*

The dating of rocks and related isotope studies
have become increasingly important branches
of the Earth Sciences. A large gap now exists
between those who obtain and interpret results,
and the field geologist who wishes to apply these
results to conventional geological problems.
This book now fills the gap. For a fuller
appreciation of results the principles of the
physical and chemical methods are described in
some detail. The results are interpreted in terms
of various problems encountered by the geologist
in routine field studies. Apart from dating the
age of rocks and minerals, related isotope studies
can, in many cases, be applied to fundamental
problems of petrology and geophysics. This
volume, though meant for geologists, will also
be found useful by persons interested in the
general field of the Earth Sciences.

C. V. R.

An Introduction to Digital Computing. By
Professor Bruce W. Arden. (Addison-Wesley
Publishing Co., Inc., U.S.A. and London),
1963. Pp. ix + 389. Price $ 6.50.

This text is designed for an introductory
course in computing techniques at the under-
graduate level. A knowledge of integral calculus

REVIEWS AND NOTICES OF BOOKS

Physical Acoustics—Principles and Methods, Volume II—Part A: *Properties of Gases, Liquids, and Solutions.* Edited by Warren P. Mason. (Academic Press, New York and London), 1965. Pp. xv + 476. Price $ 17.00.

Parts A and B of the first volume of this multivolume work were reviewed recently in *Current Science*, March 5, 1965, page 161.

In this volume, methods for detecting and generating sound waves are evaluated, followed by discussions of their use for the determination of the properties and interactions between atoms and molecules in gases, liquids, and solutions. The first three chapters of this volume consider the properties of gases from rarefied to condensed phases. Interactions or relaxations are determined by acoustic measurements and related to molecular properties by irreversible thermodynamics.

The next two chapters are concerned with the two types of relaxations found in liquids—thermal relaxation and molecular structural rearrangement. The final chapter is devoted to acoustic measurement of the material arrangement of electrolytic solutions and the propagation of ultrasonic waves.   C. V. R.

Physical Processes in Radiation Biology— *Proceedings of an International Symposium, held at the Kellog Center, Michigan State University, May 5-8, 1963.* Edited by Leroy Augenstein, Ronald Mason and Barnett Rosenberg. (Academic Press, New York and London), 1964. Pp. xv + 377. Price $ 14.00.

In this volume, thirty-four eminent biologists, biophysicists, physicists, and physical chemists take up the core problem of radiation biology—how high energy packets (protons or particles) are absorbed, distributed, and utilized in biological systems. The book emphasizes the following topics: the nature of exciton processes; the mechanisms of charge transport in biological materials; the interactions of fast and slow electrons with model systems; the importance of liquid structures in determining the development of radiation damage; the nature of the metastable species formed.
                C. V. R.

Optical Masers—*Supplement 2 of Advances in Electronics and Electron Physics*—L. Marton, Series Editor. By George Birnbaum. (Academic Press, New York and London), 1964. Pp. xi + 306. Price $ 9.50.

The demonstration, in 1960, of optical maser action in ruby launched a course of investigation and discovery so rapid that a need was created for a systematic account of experimental and theoretical results. This volume answers that need. It presents a synthesis of the extensive literature in a review of optical masers, their applications, and the theory underlying their use. Included among the specific subjects covered in this work are optical resonators, methods of excitation, spectral characteristics of maser materials, characteristics of various optical masers, and the multiple quantum effects produced by their radiation. This book will be useful to students and workers in the field of optical masers, and to all physicists and electronic engineers interested in the theory, behavior, and applications of this discipline.
                C. V. R.

The Hormones: Physiology, Chemistry and Applications (Vol. 5). Edited by G. Pincus, K. V. Thimann and E. B. Astwood. (Academic Press, New York and London), 1964. Pp. x + 966. Price $ 28.00.

This work presents an exposition of contemporary developments in pituitary hormone chemistry and metabolic function. There are seven articles in this book whose titles with their respective authors are as follows: I. Chemistry of Pituitary Hormones, by H. B. F. Dixon; II. Metabolic Actions of Pituitary Hormones, by Frank L. Engel and Jack L. Kostyo; III. The Thyroid, by J. E. Rall, J. Robbins and C. G. Lewallen; IV. *In vivo* Studies of Steroid Dynamics in Man, by J. F. Tait and Shlomo Barstein; V. Tumors and Hormones, by R. L. Noble; VI. On the Action of Mammalian Hormones, by O. Hechter and I. D. K. Halkerston; and VII. Selected Problems in Endocrine Medicine, by Rachmiel Levine.
                C. V. R.

and Hormones (Vol. 22)—*Advances
earch and Applications.* Edited by
S. Harris, Ira G. Wool and John A.
:. (Academic Press, New York and
), 1964. Pp. xx + 940. Price 114 *sh.* 6 *d.*

olume contains seven regular review
besides twenty-nine others which
the communications delivered at an
nal Symposium on Vitamin B₆ held
r of Professor Paul Gyorgy. The
: is a list of the seven review articles
eir respective authors : 1. Biochemistry
by S. P. Mistry and K. Dakshinamurti ;
Biochemistry of the Inositol Lipids, by
thorne ; 3. The Role of Organ Cultures
itudy of Vitamins and Hormones, by
. Fell ; 4. Therapy of Gynecological
s with Human Gonadotropin, by Carl
; 5. The Biochemistry of Progesterone,
therby ; 6. The Role of the Brain in
gulation of Pituitary Gonadotropin
i, by E. M. Bogdanove ; and 7. Cellular
lecular Aspects of the Antidiuretic
f Vasopressins and Related Peptides, by
. Schwartz and Linda M. Livingston.
C. V. R.

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s in Immunology (Vol. 4). Edited by
ixon and J. H. Humphrey. (Academic
New York and London), 1964. Pp. x +
rice $ 15.00.

olume like its predecessors, contains
which range over the whole field of
ogy, from a study of the biological
of specific immunologic responses,
various aspects of their protective and
ic effects, to the present knowledge
hemical structure of antibodies. This
tains seven important articles as listed
d contributed by twelve authors whose
re shown against each : 1. Ontogeny
ogeny of Adaptive Immunity, by Robert
and Ben W. Papermaster ; 2. Cellular
s in Infection, by Emanuel Suter and
ly Ramseier ; 3. Ultrastructure of
ogic Processes, by Joseph D. Feldman ;
-Wall Antigens of Gram-Positive
by Macyln McCarty and Stephen I.
5. Structure and Biological Activity of
globulins, by Sydney Cohen and Rodney
r ; 6. Autoantibodies and Disease, by
unkel and E. M. Tan ; 7. Effect of
and Bacterial Products on Antibody
:, by J. Munoz.
C. V. R.

Absorption from the Intestine. By G. Wiseman.
(Academic Press, London and New York),
1964. Pp. xvii + 564. Price 117 *sh.* 6 *d.*

In this entirely new treatise the author gives
an account of the present-day knowledge of the
absorptive and excretory functions of the
gastrointestinal tract of man and laboratory
animals. The book is dealt with in three sections.
The first part contains the following articles :
Epithelial Replacement in the Gastrointestinal
Tract ; Gastric Evacuation Time ; Lymph.

The major section, Part Two, contains the
following articles : Carbohydrate ; Protein ;
Bile ; Fat ; Cholesterol and Phytosterols ; Water ;
Sodium, Potassium and Chloride ; Calcium,
Strontium, Magnisium and Phosphate ; Iron ;
Copper, Cobalt and Manganese ; Aluminium,
Zinc and Iodine ; Nickel and Tin ; Caesium ;
Barium, Zirconium and Chromium ; Pantothenic
Acid and Folic Acid ; Vitamin B₁₂ ; Vitamin C ;
Vitamin A and Carotene ; Vitamins D, E and K.

The concluding section, Part Three, contains
the following articles : Defects of Absorption
Following Operations on the Stomach ; Massive
Resection of the Small Intestine ; Mal-absorp-
tion ; Macrocytic Anaemia in Blind Loop
Syndrome ; X-Irradiation.

An appendix under the title "Absorption of
Radioactive Isotopes by the Rat" is given at
the end of the book.
C. V. R.

**International Review of Experimental Patho-
logy.** Edited by G. W. Richter and M. A.
Epstein. (Academic Press, New York and
London).

Volume 2, 1963. Pp. xiii + 446. Price $ 16.00.
Volume 3, 1964. Pp. x + 432. Price $ 16.00.

Volume 2 of this series contains the following
articles : The Nucleic Acids of Viruses Revealed
by Their Reactions with Fluorochrome Acridine
Orange, by Heather Donald Mayor ; Cytochemi-
cal Aspects of Experimental Leukemia, by
B. Thorell ; A Lymphoma Syndrome in Tropical
Africa, by Denis Birkitt with a Note on Histo-
logy, Cytology, and Histochemistry, by D. H.
Wright ; The Use of Statistics in the Etiological
Study of Malignant Neoplasms, by Johannes
Clemmesen ; Biological Effects of Ionizing
Radiations, by Arthur C. Upton ; Microscopic
Morphology of Injured Living Tissue, by Ian
K. Juckley ; Cellular Recognition of Foreign
Matter, by Stephen Boyden ; Melanin Granules :
Their Fine Structure, Formation, and Degrada-
tion in Normal and Pathological Tissues, by
P. Drochmans,

to 0·085 mm. Length of œsophagus from anterior end, 3·03 to 3·2 mm. and from posterior end 5·57 to 6·2 mm. Spicule 1·15 to 1·23 mm. long. 0·018 mm. in width. Bursa-like apparatus present, 0·029 to 0·031 mm. in diameter.

FIGS. 1–6. *Capillaria nycticeiusi*, n. sp. Fig. 1. Anterior region of female, lateral view. Fig. 2. Posterior end of male, lateral view. Fig. 3. Vulvar region, lateral view. Fig. 4. Posterior end of male, ventral view. Fig. 5. Posterior end of female, lateral view. Fig. 6. Eggs.

Female.—Body 9·37 to 14·34 mm. long, 0·11 to 0·12 mm. in maximum width. Distance to nerve ring from anterior end of body 0·063 to 0·078 mm. Length of œsophagus from anterior end 3·22 to 4·05 mm. and from posterior end 6·11 to 10·29 mm. Vulva pre-equatorial a little posterior to œsophagus 3·32 to 4·15 mm. from anterior end. Eggs measure 0·26 to 0·28 × 0·14 to 0·16 mm. in size.

No form of this genus has been recorded so far from bats in India. The genus *Capillaria* Zeder, 1800, in bats comprise the following species, *viz.*, *C. vespertilionis* (Rud., 1819) Trav., 1918[6]; *C. pintoi* Freitas, 1934[4]; *C. pulchra* (Freitas, 1934) Lopez Neyra, 1947[1] *C. brasiliana* (Freitas, 1933) Skrjabin *et* Schikhobalova, 1954[2]; *C. angrensis* (Freitas, 1934) Skrjabin *et* Schikhobalova, 1954[2·4] and *C. miniopterœ* Thomas, 1959.[5] The new form resembles *C. vespertilionis*, *C. pintoi*, *C. angrensis* and *C. miniopterœ* in the

possession of a vulvar appendage in the females. It differs from *C. miniopterœ* in the possession of a spicule and in the absence of preanal algæ in the males. The new form differs from *C. vespertilionis*, *C. pintoi* and *C. angrensis* in having a long spicule, in the number and arrangement of anal papillæ and in the possession of three slender rays at the posterior end of male in a bursa-like apparatus. The new form is also distinguished from *C. vespertilionis* in the possession of a smooth sheath. These differences are sufficient to create a new species with the specific name *C. nycticeiusi*. n. sp.

I am thankful to Dr. S. P. Gupta, Department of Zoology, University of Lucknow, for his valuable help and encouragement.

Department of Zoology,   VINOD AGRAWAL.
University of Lucknow,
May 22, 1965.

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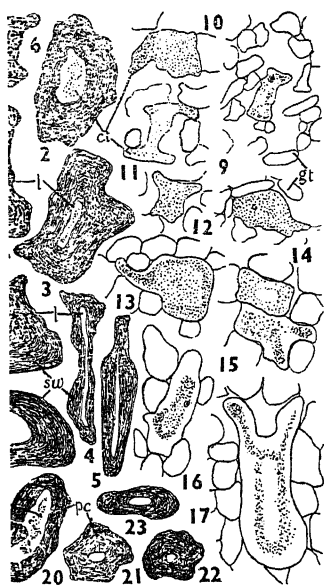
NOTES ON SOME FOSSIL SCLEREIDS

WHILE studying the anatomy of some petrified fossil woods from the Rajmahal Hills (Jurassic), some thick-walled isolated cells of various shapes and sizes were noticed therein. These look very much like sclereids found in the living forms. Earlier mention about the occurrence of similar cells in fossils is under various names like "sclerotic nests", "sclerenchymatous idioblasts," "stone cells", etc. But recent studies of living plants have shown that they cannot all be grouped under the same category. Sclereids are parenchymatous cells, non-prosenchymatous in origin and are secondarily sclerosed to form variously shaped idioblasts. A careful study, so far as we are aware, has not been made of the sclereids of fossil plants. Such sclereid characters in fossils may, along with the other morphological and anatomical characters, prove to be of diagnostic importance as in living forms.[1·2] With this in view, a preliminary study of sclereids in three petrified plant remains from Rajmahal Hills was made.

In the cortex and pith of *Brachyphyllum* shoots, numerous sclereids occur diffusely

me are more less isodiametric, brachysclereids[3] (Figs. 1-3). gated, bone-shaped, or T-shaped Figs. 4-6), while the majority ranched *astrosclereids* (Photo 2 d 8). The secondary wall of s very thick, lignified, lamellated rous crystals embedded in it and 8). The lumen narrows lereid branches and may also rystals. The nature of these be determined in fossil forms, be of calcium oxalate as are lants like *Nymphœa*,[4] *Araucaria*[2]

gs, 1-8. Various types of sclereids in t, × 132. Figs. 9-17. Some developereids in *Brachyphyllum* shoot, × 132. hysclereids in *Ptilophyllum cutchense*, ¦3. Brachysclereids in the unidentified ¦. (*cr*, crystal; *ct*, cell content; *gt*, umen; *p*, pit; *pc*, pit canal; *sw*,

ntal stages of various types of not be traced for want of , but some younger stages were section of the primary shoot. d be recognised by their large ly dense contents as compared ouring cells (Fig. 9). Small om similar initials carrying the last, penetrating into the sur-may also be recongnised
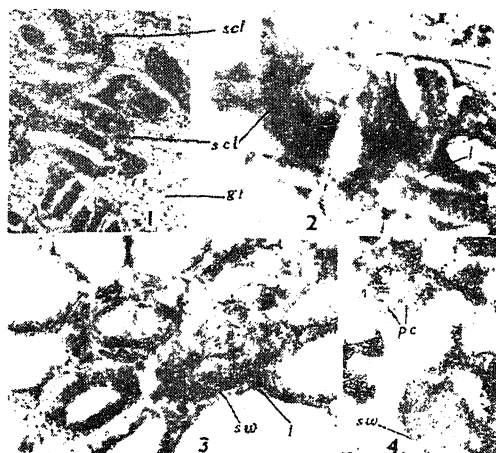
(Figs. 10-15). The concentration of the protoplast towards the inner side of the lumen leading to the beginning of secondary wall formation could also be seen (Figs. 16 and 17). Evidently, from such initial stages, are differentiated the brachy, osteo and astrosclereids as in living forms. A small denser mass seen in the protoplast may well mark the position of the nucleus (Figs. 9, 12, 14 and 16). The genus *Brachyphyllum* has been compared to the living genus *Araucaria*.[5] The sclereids in their structure and distribution pattern closely resemble those of *Araucaria*.[2] The occurrence of polymorphic sclereids, presence of numerous crystals and absence of pit-canals in their secondary wall are other features of resemblance. This lends a little further support to the comparison between the living *Araucaria* and fossil *Brachyphyllum*.

Sclereids were also found in the rachis (Photo 3) and pinna of *Ptilophyllum cutchense* Morris, either occurring singly or in groups in the ground tissue, forming round the vascular bundles, a more or less continuous ring along with other mechanical tissues. In the pinna, they occur mostly in the palisade and rarely in the spongy mesophyll. The sclereids are mostly rounded, or oval, slightly elongated or roughly isodiametric, with thick, lignified lamellated secondary walls (Photo 3) traversed by pit-canals (Figs. 19 and 20) and containing

PHOTOS 1-4. Photo 1. Part of a longitudinal section of the shoot of *Brachyphyllum* showing a group of sclereids, × 82·5. Photo 2. Two sclereids magnified to show the lamellated wall and the narrow lumen., × 66. Photo 3. Four sclereids enlarged to show the lamellated wall, × 97. Photo 4. Sclereids in the pith region of the unidentified conifer stem, × 88. (*gt*, ground tissue; *l*, lumen; *pc*, pit-canal; *scl*, sclereid; *sw*, secondary wall.)

made on August 25th of a group of 14 mosquitoes but none of the mice became ill. All of the mosquitoes found dead in the cage after arrival in Poona and those remaining alive after the August 25th feeding were stored at $-50°$ C. Most of these mosquitoes were tested individually, or in small groups, for the presence of virus. The mosquitoes were ground in a mortar and suspended in 1·5 ml. of bovine albumin phosphate saline containing 1,000 units of penicillin and 1 mg. of streptomycin per ml. Following light centrifugation to throw down the larger particles, the supernatant fluid of each suspension was inoculated in 0·02 ml. volumes intracerebrally into two groups of two-day-old mice. Chikungunya virus was isolated from a pool of two mosquitoes, one of which presumably fed on the mouse from which virus was isolated.

On September 24th, 1964, a hospital sweeper became ill and was admitted to the Carmichael Hospital of the School of Tropical Medicine, Calcutta. His temperature was 100·5° F. and he complained of severe bodyaches and joint pains. No rash was seen at that time. The patient was exposed to a group of 50 mosquitoes but only 20 became engorged. The titer of chikungunya virus in the blood of the patient at the time the mosquitoes fed was $10^{2·8}$ $LD_{50}/0·02$ ml. Three mosquitoes died in Calcutta and were discarded. The engorged mosquitoes were transported in Barraud boxes in wooden containers to Poona by train and arrived on October 2, 1964. On arrival, 14 mosquitoes were found dead. These were ground in one pool and inoculated intracerebrally into infant mice. Chikungunya virus was isolated from this group of mice. On October 9th each of the remaining three mosquitoes was fed on a different two-day-old mouse. The mice did not become sick. A pool of the three mosquitoes was tested for the presence of virus by intracerebral inoculation of a suspension prepared from them into infant mice, but no virus was isolated.

Sixty-eight *Aedes œgypti* engorged on a third patient from whom chikungunya virus was isolated. In this case the blood sample obtained at the time the mosquitoes engorged had a titer of $10^{3·5}$ $LD_{50}/0·02$ ml. The mortality among this group of mosquitoes was high and only 16 survived the trip to Poona. Unfortunately, the mosquitoes dead on arrival were not tested for virus. No virus was isolated from any of the remaining mosquitoes fed on this patient.

It has therefore been possible to demonstrate the infection of *Aedes œgypti* following engorgement on the blood of humans during the period of viremia. Although only two mosquitoes were shown to become infected, the titers of virus in the blood of these patients at the time the mosquitoes fed was not very high. The stage of the infection during which the titer of virus is highest is not known in chikungunya virus infection in man but much higher titers have been found in other patients during the course of the clinically apparent illness and one would expect that with higher titers a larger proportion of the mosquitoes would become infected after feeding.[5,6]

These results provide further evidence for the role of *Aedes œgypti* as an important vector of chikungunya virus and suggest that this virus might become established in a human population by person-to-person transfer by bites of *Aedes œgypti*. A city the size of Calcutta might very well be able to provide a sufficiently large susceptible population at all times to maintain chikungunya virus as an endemic infection.

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LETTERS TO THE EDITOR

ELASTIC SCATTERING OF 1·12 MeV GAMMA-RAYS FROM PLATINUM AND TANTALUM

In an earlier communication[1] it was pointed out that the available experimental and theoretical data did not permit any reliable estimation of elastic scattering cross-sections from different elements at various gamma-ray energies and angles. It was suggested that our experimental results on Z-dependence when combined with the exact calculations of Brown and Mayers[2] for K-shell electrons in mercury should give a reliable estimate of the scattering cross-sections from different elements. In order to

The results obtained with the procedure outlined above are given in Table I. The experimental results are those of Narasimhamurty et al.[3] Also listed in the table are the values calculated from the form factor results of Franz.[4] Our estimated values are lower than those calculated by the form factor method given by Franz, but show better agreement with the experimental values at all angles except at 20° where the experimental values are lower; this may be due to the uncertainties involved in the measurement because of the difficulties encountered in the isolation of elastic scattering from inelastic scattering at this angle.[1]

TABLE I

Comparison of estimated and experimental values of elastic scattering cross-sections

Scattering angle (°)	Momentum transfer (q)	$(d\sigma/d\Omega)^{(80,q)}_{R+T}$	(n)	$(d\sigma/d\Omega)^{(z,q)}_{R+T} \times 10^{-26}$ cm.^{2}/sr.					
				Platinum			Tantalum		
				Estimated	Franz (f.f.)	Experimental	Estimated	Franz (f.f.)	Experimental
20	0·76	7·1	3·3	6·50	6·30	5·50 ±0·82	5·2	5·17	4·51 ±0·67
30	1·13	1·82	4·2	1·64	1·83	1·29 ±0·20	1·25	1·51	1·09 ±0·17
45	1·65	0·26	4·8	0·23	0·506	0·157 ±0·023	0·17	0·417	0·127 ±0·019
60	2·19	0·05	5·05	0·047	0·202	0·0554±0·0084	0·036	0·166	0·0342±0·0051
90	3·1	0·022	5·2	0·0197	0·063	0·0180±0·0027	0·0143	0·044	0·0119±0·0018

demonstrate the applicability of the method we have estimated the values of the elastic scattering cross-sections of 1·12 MeV gamma-rays from platinum and tantalum at various angles and compared the estimated values with the available experimental and theoretical results.

The method of estimation consists in plotting the scattering amplitudes for mercury at different momentum transfers after taking into account the contributions of L-shell electrons and nuclear Thomson scattering. From such a plot it is possible to determine the value of elastic scattering cross-section for mercury at any energy and scattering angle. Making use of the experimental value of the index 'n' of Z-dependence as reported in reference 1 it is possible to calculate the elastic scattering cross-section for any element ($Z \geqslant 47$) from the relation,

$$(d\sigma/d\Omega)^{(Z,q)}_{R+T} = (d\sigma/d\Omega)^{(80,q)}_{R+T} \times (Z/80)^n$$

Physics Department,
Punjabi University,
Patiala, *June* 18, 1965.

S. Anand.
M. Singh.
B. S. Sood.

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SYNTHESIS OF LANCEOLATIN-B

Lanceolatin-B (I) was isolated from the root bark of *Tephrosia lanceolata*[1] and was shown to be furano-(2' : 3' : 7 : 8)-flavone on the basis of degradative evidence by Rangaswami and Sastri.[2] Conversion of pongamol and nor pongamol to lanceolatin-B was effected by Narayanaswami, Rangaswami and Seshadri[3] and Rao and Venkateswarlu[4] respectively.

SCIENCE NOTES AND NEWS

Award of Research Degree

Utkal University has awarded the Ph.D. Degree in Botany to Shri Banchhanidhi Misra for his thesis entitled "Autecological Studies on *Ipomoea crassicaulis* (Benth.) Robinson".

Indian Association of Biological Sciences

At a meeting of biologists held in Calcutta in January 1965, an Association called "The Indian Association of Biological Sciences" was formed. The main aim of the new Association will be to create a common forum of Indian Biologists and try to integrate the research acivities of biologists working in different fields. A Steering Committee to formulate the detailed scheme of the Association was elected at the meeting.

Any suggestions may please be communicated to Prof. T. S. Sadasivan (Secretary, IABS), University Botany Laboratory, Madras-5, or Prof. P. Maheshwari (Chairman), Department of Botany, Delhi University, Delhi.

Further information can be had from the Treasurer Dr. B. S. Chauhan, Zoological Survey of India, 34, Chittaranjan Avenue, Calcutta-12.

Symposium on Indian Medicinal Plants

A symposium on 'Recent advances in the development, production and utilisation of medicinal and aromatic plants in India' under the auspices of Central Indian Medicinal Plants Organisation (CIMPO) will be held at Lucknow on 12th, 13th and 14th January, 1966.

The symposium will confine itself to the recent developments in the production and utilisation of medicinal and aromatic plants in India since 1955.

For contribution of papers and other information, please write to Dr. S. C. Datta, Central Indian Medicinal Plants Organisation, 4, Sapru Marg, Lucknow.

Symposium on Radioactivity and Metrology of Radionuclides

An All-India Symposium on Radioactivity and Metrology of Radionuclides will be held at Trombay from December 13-17, 1965 under the auspices of the Atomic Energy Establishment, Trombay. The Symposium will cover various aspects pertinent to the problems of radioactivity measurements in fields such as radiological protection, studies of natural radioactivity, applications of radioisotopes in physical and life sciences and industry and radioisotope standardization.

Scientists wishing to participate in the Symposium are requested to write to Dr. U. C. Gupta, Secretary, All-India Symposium on Radioactivity, etc., N.I.S. Section, Electronics Division, Atomic Energy Establishment, Tromaby, Bombay-74 AS.

Symposium on "CNS-DRUGS"

A symposium on "CNS-DRUGS" will be held from 24-30 January 1966 at Regional Research Laboratory, Hyderabad (India), one of the constituent laboratories of Council of Scientific and Industrial Research, Government of India. The Symposium is expected to be attended by about 45 invited participants from India and abroad. The proceedings of the Symposium will be published by the middle of 1966 by the Council of Scientific and Industrial Research, New Delhi. Further details about the Symposium may be obtained from Dr. P. B. Sattur, Regional Research Laboratory, Hyderabad-9.

Molecular Crystals, an International Journal

Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York City 10011, announce plans to publish a new quarterly journal entitled *Molecular Crystals,* under the editorship of G. J. Dienes, Brookhaven National Laboratory and M. M. Labes, Franklin Institute Research Laboratories. This journal will publish original research papers dealing with molecular crystals and related topics such as crystallinity in polymers, liquid and plastic crystals and systems of biological interest.

As a quarterly publication with the first issue commencing January 1966, the subscription rate will be $ 20.00 per year, with a special rate to individuals of $ 9.50.

THE NEW PHYSIOLOGY OF VISION

Chapter XXIII. The Colours of the Roses

Sir C. V. RAMAN

ROSES have been known in India for ages past and have been highly esteemed for beauty and fragrance. It is scarcely possible, therefore, to commence a paper on colours of roses without some reference to Indian rose known botanically as *Rosa semperflorence*. It is a shrub which is exceedingly vigorous in growth and flowers freely and perpetually. The blooms are lovely, each having some forty petals. They appear as clusters at the end of tall canes growing from the base of the shrub and are characterised by their soft pink colour and a sweet scent which perfumes the air around. These roses have been in extensive cultivation for various purposes, in particular for the production of the essential-oil perfume known as attar. If groups of these shrubs are planted out in a garden, they make a very satisfying show and colour.

The reason why it appeared desirable to devote a whole chapter to the colours of roses is that the rose has long been a highly popular flower and enthusiastic rose-lovers are to be found all the world over. Interest in the rose continues unabated and thousands of varieties have been created by crossing and inter-mixing the different species with each other. The colour of a rose forms a major part of its aesthetic appeal. Quite naturally, therefore, it has been a decisive factor in the development, selection and propagation of new varieties. How far this activity has proceeded may be evident from *The Pocket Encyclopædia of Roses* (1963), published by the Blandford Press in London. No fewer than 421 named varieties have been reproduced in full colour in this publication. It is stated that great care is taken to achieve a high degree of accuracy in the representation of the colours and to secure such accuracy, the illustrations were printed in six colours. Seeing these pictures, one may well ask, why do roses exhibit such colours and why do the different roses differ so markedly from each other? It is the purpose of this chapter to present answers to these questions.
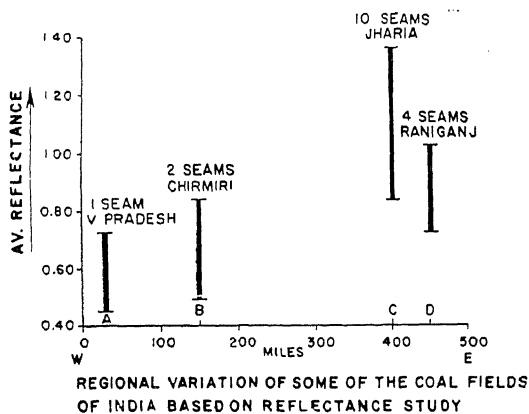
The Colour Categories.—The colour of a flower has its origin in the presence in its petals of a material which we may refer to as the floral pigment. This exercises an absorption on light which is of a selective nature, greater in some parts of the visible spectrum and much less or even absent in other parts of it. As a consequence, diffuse daylight which is incident on the petals before it can emerge again from them after internal scattering has its spectral constitution much altered, some parts of the spectrum being weakened relatively to the others. When the light having this altered spectral character reaches the eyes of an observer, the characteristics of the visual mechanism determine the results of the visual synthesis and hence also the perceived colour. Thus, the colour exhibited by a rose is determined by our faculties of perception and by the spectral characters of daylight as it emerges after diffusion within the petals, these characters being themselves dependent on the quantity of floral pigment contained in the petals and its absorptive properties.

In the preceding chapter, a scheme for the classification of floral colours was suggested. This was based on the subdivision of the visible spectrum into four parts, consisting respectively of the blue sector, the green sector, the yellow sector and the red sector. Of these four, the yellow sector covers the narrowest range of wavelengths but nevertheless transcends all the others in respect of its influence on the perceived colour. Placing the four sectors in the order stated and indicating by the symbol 1 the absence of absorption and by the symbol 0, a complete absorption of the sector concerned, we obtain sixteen categories of colour which are indicated by the appropriate symbols. The eight categories which here concern us are (1111), (0111), (0011), (0001), (0000), (1001), (1011) and (1101). These represent colours which may be termed respectively as white, yellow, orange, red, black, pink, rose and purple. These assignments are based on spectroscopic observations of a great many flowers exhibiting various colours. If the absorption

to older seams, which is indicated by a decrease in vitrinoid types V_7, V_8 and V_9 and a corresponding increase of types V_{10}, V_{11}, V_{12} and V_{13}. This is illustrated in the percentage bar diagram on the right of Fig. 1. The average reflectance, also plotted, shows a nearly linear increase with depth. This increase of rank with depth has previously been demonstrated by Ganju[5] (1946) and by Lahiri[6] (1952) from chemical and refractive index studies respectively. Ganju showed the existence of a gradual loss in volatile matter when proceeding downward in the section. Ganju's volatile matter curve is illustrated on the left of the stratigraphic column. The present study indicates that not only chemically but also reflectance-wise the law of Hilt (1873) applies in the Jharia coal field. A similar relationship was observed in the coals of Raniganj coal field, but between these two areas the relationship is not apparent notwithstanding the fact that the coals of the latter are stratigraphically younger than those of Jharia.

The seams of Dishegarh and Samla of Raniganj coal field show lateral variation as noticed by an increase in reflectance from west to east. This lateral variation in the seams of Raniganj coal field has been mentioned by Ganju (1946) based on chemical studies.

Geographically the Bihar coals occupy the N.E. portion, the Chirmiri coals the central portion and the Vindhya Pradesh coals the N.W. portion of the Gondwana coal fields. The variation in average reflectance plotted in Fig. 2

REGIONAL VARIATION OF SOME OF THE COAL FIELDS OF INDIA BASED ON REFLECTANCE STUDY

FIG. 2

indicate that there is a decrease in rank of these coals from N.E. to N.W. Accordingly coals of high rank occur in N.E. portion, while coals of low rank are found in the N.W. part.

The average petrographic composition of the coals studied for reflectance from Jharia coal

field are plotted by percentage ban as shown in Fig. 1. There is no relationship indicated between the min depth. However, it is clear from Tu

TABLE I

Name of the seam	Vitrinite content
Raniganj (Average of 4 seams) ..	63·43
Jharia (Average of 10 seams) ..	48·16
Chirmiri (Average of 2 seams) ..	40·00
Vindhya Pradesh (Average of 2 samples)	45·10

there is a corresponding decrease in portion of vitrinite and increase of from Raniganj to Vindhya Pradesh to N.W.).

The reflectance study reveals that from the middle portion of the J fields (Seams No. 8, 14) are likely be than those of the top and bottom po cause they are characterized by thos types which can impart fluidity duri The coals from Raniganj particularly the western part of the field, are re coking coals, but they will not produ good strength or stability. They suitable for blending purposes w coking coals. Similarly coals from although possessing enough vitrinoid contain the required type to incluc during carbonization. These coals also suited for controlled and proportiona with other coals in order to produc factory coke produce.

In conclusion, it can be mentione detailed programme of reflectance stud various coals of India, in co-ordina chemical studies, will prove not invaluable tool in industrial applica also will be useful in the academic ur ing of the nature of various coals in space.

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LETTERS TO THE EDITOR

ON THE ENERGY LEVELS OF Mo^{92} WITH DIFFERENT POTENTIALS*

WARKE AND WAGHMARE[1] have shown that as long as the collective effects are neglected, calculations in nuclear spectroscopy do not depend much on the radial shape of the two-body nuclear potential. They illustrated this point with the use of Gaussian, Yukawa and exponential potentials. We have, however, carried out our calculations on Mo^{92} with the use of Coulomb potential as well. Table I lists

TABLE I

J		0^+	2^+	4^+	6^+	8^+
E (MeV)						
Experimental [2]	G.S.	1·54	2·33	2·66	2·79	
Gaussian	G.S.	1·44	2·37	2·67	**2·79**	
Yukawa	G.S.	1·64	2·37	2·64	2·79	
Coulomb	G.S.	1·73	2·44	2·68	2·79	

the energy levels of this nucleus arising due to the configuration $(g_{9/2})^2$. It is clear from this table that the values of the energy levels for Mo^{92} in the three cases are in quite good agreement with each other. This may help a lot in correlating the data of various authors obtained with different potentials, since the splittings of the levels do not depend much on the radial form of the two-body potential.

Physics Department,   VIJAY KUMAR.
Panjab University,   NARESH KUMAR.
Chandigarh, *May 6, 1965.*

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ABSOLUTE PHOTOELECTRIC CROSS-SECTIONS OF 145, 280 AND 320 KeV GAMMA-RAYS

THOUGH there are many theoretical expressions developed for the calculation of the photoelectric cross-sections, no single expression can be employed for all elements and for all energies especially in the low-energy region. Each expression is suitable to be used in a fixed region of energy and for a limited range of elements, All these are summarized in Grodstein's Tables.[1] The values generally used as standard values are obtained from interpolations made from the values obtained from various theoretical expressions. But recently Nagel[2] developed explicit expressions for both differential and total photoelectric cross-sections which suit all elements and all energies. Hultberg *et al.*[3] calculated the photoelectric cross-sections from Nagel's expressions between the energy region 120 to 662 KeV in lead and uranium only. So photoelectric cross-sections at 145, 280 and 320 KeV gamma-energies in elements Cu, Ag, Sn, Ta, Pt and Pb are computed from the recently developed Nagel's expressions and a comparative study is made in the light of the values computed from Heitler[4]-Stobbe[5] and Sauter[6]-Stobbe[5] expressions as well as with the interpolated values from Grodstein's Tables (NBS Circular 583).

In these calculations the screening constant 0·3 for all the values of Z is used. Total cross-sections are obtained by using λ total/λ K values. Nagel's values are obtained from Dr. Hultberg, BESK Service, Nobel Institute of Physics, Stockholm, which are computed on computors. Total photoelectric cross-sections from Grodsteins Tables are plotted as a function of energy on graph sheets (75 cm. × 50 cm.). The interpolated values are obtained for the required elements at the required energies. The results are given in Tables I, II and III.

TABLE I
Photoelectric cross-sections at 145 KeV

Element		Heitler-Stobbe	Sauter-Stobbe	Nagel	NBS
Cu	..	9·95	10·6	9·6	10·5
Ag	..	77.20	86·2	74·9	78·6
Sn	..	96·9	108·2	96·3	100·0
Ta	..	417·3	465·5	421·7	442·5
Pt	..	527·2	586·7	535·2	552·5
Pb	..	627·2	700·9	637·1	688·0

TABLE II
Photoelectric cross-sections at 280 KeV

Element		Heitler-Stobbe	Sauter-Stobbe	Nagel	NBS
Cu	..	1·1	1·17	1·29	1·32
Ag	..	9·1	11·7	11·2	12·2
Sn	..	12·8	16·2	14·5	15·1
Ta	..	60·0	71·5	70·3	72·8
Pt	..	78·0	94·1	92·1	91·5
Pb	..	94·4	115·4	109·4	111·2

SYNTHESIS OF SOME 2′-OXYGENATED FLAVONES*

V. V. S. MURTI, P. V. RAMAN AND T. R. SESHADRI

Department of Chemistry, Delhi University, Delhi-7

IN addition to 5, 6-dimethoxyflavone (I) three new flavones having 2′-methoxyl substituent have been reported to occur in the Mexican tree *Casimiroa edulis*.[1-3] These are 5, 6, 2′-trimethoxyflavone (II), zapotin (III) and zapotinin (IV). The structures of (I) and (II) were confirmed by comparison with synthetic compounds[4-5] but those of (III) and (IV) were inferred from spectral data, colour reactions and degradations and no comparison with synthetic substances was made.

I R = H
II R = OCH₃

III R = CH₃
IV R = H

We were interested in the structures assigned to zapotin and zapotinin for a number of reasons : (i) Work has been going on in our laboratory on the Wessely-Moser rearrangement of flavonoids, the factors which govern this change and the mechanism involved.[6,7] The three flavones mentioned above seemed to offer interesting possibilities for such a study.[8] (ii) The validity of the constitutions suggested for zapotin and zapotinin appeared to require synthetic confirmation for the following reasons : (a) Zapotin was reported to undergo only partial demethylation in the 5 position on fusion with potassium hydroxide,[1] a reaction known to effect fission of the pyrone ring and to bring about other drastic changes in flavonoids. (b) Salicylic acid and resorcinol were identified in the products of potash fusion of demethylzapotin[1]; while salicylic acid could be traced to the side-phenyl nucleus, the origin of resorcinol could not be definitely established.[3] (c) The oxygenation pattern of the A-ring of zapotin was inferred chiefly from the colour reactions of demethylzapotin, including Bargellini's test but no degradation product to substantiate this conclusion was isolated.[3] It is known

that this test is not specific for compounds of the 5, 6, 7-trihydroxy type and other substances also give a positive reaction.[9,13] It was, therefore, considered necessary to synthesise 5, 6, 2′-tetramethoxyflavone and 5-hydroxy-6, 7, 2′-trimethoxyflavone by unequivocal methods and compare their properties with those of zapotin and zapotinin. This has now been done and though direct comparison with the compounds isolated from *Casimiroa edulis* could not be carried out, the differences in the properties of the synthetic and the natural products make it clear that zapotin and zapotinin cannot have the structures attributed to them. Our work is still in progress ; however, in view of the recent publication of Farkas and Nogradi[14] our main findings are summarised here.

The starting material for the synthesis of 5, 6, 7, 2′-tetramethoxyflavone was 2-hydroxy-4, 5, 6-trimethoxyacetophenone[15]; this was esterified with o-methoxybenzoyl chloride[16] and the resulting ester was isomerised to the dibenzoylmethane using potassium hydroxide in pyridine solution.[17] Ring closure by boiling the diketone with sodium acetate in glacial acetic acid solution afforded the required tetramethoxyflavone. Partial demethylation of the latter with boiling 20% hydrochloric acid gave 5-hydroxy-6, 7, 2′-trimethoxyflavone and complete demethylation to 5, 6, 7, 2′-tetrahydroxyflavone was effected with hot hydriodic acid. The acetates of these compounds were prepared by the acetic anhydride-sulphuric acid method. Attempts were also made to prepare 5, 6, 7, 2′-tetramethoxy- and 5-hydroxy-6, 7, 2′-trimethoxyflavones from 5, 7, 8, 2′-tetramethoxyflavone using the Wessely-Moser rearrangement. The last substance was prepared from 2-hydroxy-3, 4, 6-trimethoxyacetophenone[15] following a route similar to the synthesis of 5, 6, 7, 2′-tetramethoxyflavone. Demethylation of the tetramethoxyflavone to 5-hydroxy-7, 8, 2′-trimethoxyflavone could not be effected with 20% hydrochloric acid but heating with aluminium chloride in nitrobenzene solution was successful. Complete demethylation to 5, 7, 8, 2′-tetrahydroxyflavone was carried out with aluminium chloride in boiling benzene. The acetates of these compounds were prepared by the same method as above. The m.p. and the

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spectral properties of some of our compounds were different from those of Farkas and Nogradi[14]; however, the properties of 5, 6, 7, 2'-tetramethoxy- and 5-hydroxy-6, 7, 2'-trimethoxyflavones are markedly different from those reported for zapotin and zapotinin[1,3] thus showing that the latter cannot have the structures ascribed to them. The properties of 5, 7, 8, 2'-tetramethoxy- and 5-hydroxy-7, 8, 2'-trimethoxyflavones also do not agree with those of zapotin and zapotinin ruling out these alternative structures also.

Attempts to convert 5, 7, 8, 2'-tetramethoxyflavone to 5, 6, 7, 2'-tetrahydroxyflavone by prolonged refluxing with hydriodic acid and acetic anhydride led to inconclusive results. At one stage of our investigation it was considered possible that the product could be 2', 3', 4', 6'-tetrahydroxyflavone (cf. ref. 8). The corresponding tetramethoxyflavone was synthesised from o-hydroxyacetophenone and 2, 3, 4, 6-tetramethoxybenzaldehyde[19] (now prepared from 1, 2, 3, 5-tetramethoxybenzene[18] by the dimethylformamidephosphorus oxychloride method) via the chalcone and subsequent oxidation with selenium dioxide. But this compound was different from the complete methyl ether of the hydriodic acid demethylation product of 5, 7, 8, 2'-tetramethoxyflavone. Further work on this problem and attempts to determine the correct structures of zapotin and zapotinin is in progress.

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CARNEGIE INSTITUTION OF WASHINGTON—YEAR-BOOK 63 [*]

THE increased research activities of the various deparments of the Carnegie Institution of Washington during the year 1963-64 are at once apparent from the enlarged size of the Year-Book 63. The Report of President Caryl P. Haskins occupies 20 more pages than last year's, and the Departmental Reports occupy nearly 100 more pages than last year's. Dr. Haskins's thesis on "The Process of Planning Both in and for Science" is highly thoughtful and penetratingly analytical and demands careful study.

In the Mount Wilson and Palomar Observatories programmes of work during the year on solar observations, planets and comets, radio sources and galaxies have yielded some noteworthy results. An analysis of the isotope bands $C^{12}C^{13}$ in the spectrum of comet Ikeya (1963 a) taken with the 200-inch telescope has indicated a C(12)/C(13) ratio which is the same as in terrestrial and meteoritic material. This observation suggests that the cometary material came from the region of the terrestrial group of planets rather than from the region of the major planets, assuming, of course, that comets were formed at the same time as the solar system.

Earlier work had indicated that the chromospheric activity of a main-sequence star is

following were the speakers : W. B. Thompson—Kinetic theory of plasma ; Russel Kulsrud—General stability theory in plasma physics ; G. Ecker—Gas discharge theory ; M. N. Rosenbluth—Topics in microinstabilities ; H. P. Furth —Instabilities due to finite resistivity or finite current-carrier mass ; P. A. Sturrock—Nonlinear theory of electrostatic waves in plasmas ; C. Mercier—Equilibre et stabilite des systemes toroidaux en magnetohydrodynamique au voisinage d'un axe magnetique ; B. Bertotti—Boundary layer problems in plasma physics.

The second section comprised seminars and the following were the speakers : R. M. Kulsrud —Introduction for papers on adiabatic invariance ; R. M. Kulsrud—Adiabatic invariant of the harmonic oscillator ; M. Kruskal—The gyration of a charged particle.   C. V. R.

Advances in Hydro Science, Volume I. Edited by Ven Te Chow. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. 442. Price $ 15.00.

This new serial publication will be the source work for the latest data emerging from the study of water. It will cover the physical, chemical, biological, biochemical, radioactive and hydrodynamical aspects of water ; the man-made instruments, machines and structures employed in connection with water ; the use, re-use and control of water resources ; and the many specialized problems occurring within these broader classifications.

The present volume contains five articles as listed below : 1. Sonar, by Bradford A. Becken ; 2. Hydroelasticity, by S. R. Heller, Jr. ; 3. Statistical Hydrodynamics in Porous Media, by Adrian E. Scheidegger ; 4. New Contributions to Hydroballistics, by F. S. Burt ; and 5. Hydraulics of Wells, by Mahdi S. Hantush.
C. V. R.

Advances in Protein Chemistry, Volume XIX. Edited by C. B. Anfinsen, M. L. Anson, J. T. Edsall and F. M. Richards. (Academic Press, Inc., 111, Fifth Avenue, New York), 1964. Pp. viii + 408. Price $ 14.50.

The present volume of this well-known series contains four long articles. The first article is on "The Hemoglobins", by G. Braunitzer, K. Hilse, V. Rudloff and N. Hilschmann. This discusses in great detail the results of the X-ray analysis of hemoglobin and exhibits in the form of charts the amino-acid sequences with corresponding peptide chains in normal human hemoglobin. The second article is on "Hemoglobin and Myoglobin", by Alessandro Rossi Fanelli, Eraldo Antonini and Antonio Caputo. The third article is on "Linked Functions and Reciprocal Effects in Hemoglobin : A Second Look, by Jeffries Wyman, Jr., and the fourth and concluding article is on "Thermodynamic Analysis of Multicomponent Solutions", by Edward F. Casassa and Henryk Eisenberg.   C. V. R.

An Introduction to Thermodynamics. By D. C. Spanner. [Academic Press, Inc. (London), Ltd., Berkeley Square House, Berkeley Square, London W. 1], 1964. Pp. xii + 278. Price 47 sh. 6 d.

This book is intended to introduce the subject of Thermodynamics to students of science in general and of biology in particular. The subject is traversed in a systematic fashion and with a special purpose in view, namely, to enable the foundations of such an abstract subject to be grasped and utilized by the students for the better understanding of their own special fields of scientific activity.

To indicate how the student is led on from the more elementary to the deeper aspects of thermodynamics, the titles of the fifteen chapters into which the book is divided are listed below : 1. The Nature of Thermodynamics ; 2. The First Law of Thermodynamics ; 3. Some Mathematical Topics ; 4. Reversibility and Irreversibility ; 5. Perfect Gases and Some Other Things ; 6. The Second Law of Thermodynamics ; 7. Entropy and Free Energy ; 8. Equilibrium and the Direction of Spontaneous Change ; 9. The Statistical Interpretation of Equilibrium and Entropy ; 10. Chemical Reactions and Membrane Equilibria ; 11. Chemical and Transport Processes in Dilute Solutions ; 12. Dilute Solutions of Electrolytes ; 13. The Thermodynamics of Water Relations ; 14. Photosynthesis, Thermodynamic Efficiency and ATP ; and 15. The Thermodynamics of Irreversible Processes.

The book is warmly recommended.
C. V. R.

Advanced Methods of Crystallography. Edited by G. N. Ramachandran. (Academic Press, New York and London), 1964. Pp. 270. Price 65 sh.

A Winter School on Advanced Methods of Crystallography was organized at Madras immediately following the International Symposium on Protein Structure and Crystallography during January 1963. Some of the scientists who attended the symposium were requested to deliver a course of three lectures each. The

sent volume contains a report of the lectures delivered, which have been amplified and itten up for publication by the lecturers. Nine lectures appear in this volume. As is urally to be expected, three of them are by lian authors.   C. V. R.

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emical Transport Reactions. By Herald Schafer. (Academic Press, New York and ondon), 1964. Pp. 161. Price $ 6.80.

This is a translation of a German edition of book published a few years ago. It has been ised so as to take into account all significant stigations in the field made more recently. mical transport reactions cause the migra-1 of solids (or liquids) *via* the gas phase means of heterogeneous equilibria. They r a multitude of applications in preparative mical work. The predictability of the cesses of heterogeneous reversible reactions litates their use in purification procedures, stal growing, and mineralization systems. s monograph presents an extensive survey of literature.

he six chapter headings in the book give idea of the scope of the book, *viz.*, 1. Intro-tion and Historical Review; 2. Experimental Theoretical Principles; 3. The Transport iolid Substances and Its Special Applications; Information on the Reaction Process in the Phase; 5. Chemical Transport Processes as Aid in Preparative Chemistry. Combination Transport Reactions with Other Processes; 6. The Use of Transport Experiments in Determination of Thermodynamic Values.
                    C. V. R.

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cyclic Hydrocarbons, Volumes I and II. By Clar. (Academic Press, New York, and ringer-Verlag, Berlin), 1964. Volume I: . xxvii + 487. Volume II: Pp. lvii + 487.

the present reviewer these two volumes of *cyclic Hydrocarbons* are particularly wel-, because he has made frequent use of 's 1952 book on *Aromatische Kohlenwasser- Polycyclische Systeme*. In an age of i-author books, it is a refreshing change to a book of nearly 900 pages written by a author, who incidentally is supremely ilied to write it. The great majority of yclic hydrocarbons were prepared by him the main method for the reduction of poly- quinones to hydrocarbons was developed im. One exception is an interesting chapter Carcinogenesis" written by Miss Schoental. usly enough, the new English edition has

the same deficiency which was characteristic of the German book: the absence of a subject index. It is true that the very systematic treat-ment of the hydrocarbons makes the hydro-carbons themselves not too difficult to locate, but nonetheless a subject index would have fulfilled the useful purpose of listing the numerous related topics which are treated in the book.

Part I consists of 19 chapters and about 200 pages and covers nomenclature, qualitative theoretical aspects such as the aromatic sextet and its significance concerning the properties of aromatic systems, spectroscopic, magnetic, and electrical properties, and general methods for the preparation of aromatic hydrocarbons. The remainder of the two volumes consists of a systematic treatment of all the known polycyclic hydrocarbons extending from benzene to hydro-carbons consisting of 5- and 6-membered rings with formally fixed double bonds. The author states explicitly that the book is mainly con-cerned with the presentation of experimental material and empirical rules; M.O. and V.B. methods and other theoretical aspects are dealt with very briefly and in qualitative terms. Thus the reader must look elsewhere for adequate coverage of such areas as the semiconductor properties of polycyclic hydrocarbons. The chapter on the possibility of bond fixation by substitution might well have been omitted if space could not be found for more modern and satisfying explanations of the experimental facts. More space might have been devoted to methods of preparation, for instance reduction by alu-minium alkoxides, the procedure of Kelly and Shannon, and Raney nickel desulphurisation. Among the reagents for dehydrogenation, an omission is dichlorodicyanobenzoquinone; and there is no reference to Jackman's useful review of hydrogenation-dehydrogenation reactions.

A few typographical errors have been noticed such as 'phenanthrene' for "phenanthraquinone" (p. 173), and 'Baly' for "Bally" (p. 189). The Scholl condensation, undoubtedly the most valuable reaction for the synthesis of polycyclic quinones, has been treated very briefly and there is no discussion of its mechanism in contrast with Balaban and Nenitzescu's chapter on the Scholl reaction in Olah's *Friedel-Crafts and Related Reactions*. These omissions are mentioned merely as suggestions for inclusion in a future edition which is sure to be called for in a short time, because of the wide interest of polycyclic hydrocarbons in general organic chemistry, dyestuff chemistry, and cancer,

green sector in the spectrum of the light issuing from the material.

The Sensation of Blue.—Spectroscopic examination of a sample of blue silk showed a complete extinction of the yellow region in its spectrum. This extinction manifested itself as a dark band covering the wavelength range from 560 mμ to 590 mμ. The red sector of the spectrum also exhibited a notable diminution of brightness, as also a dark band crossing the spectrum and covering the spectral range from 620 mμ to 650 mμ. Despite these manifestations of absorption in it, the red sector of the spectrum was very far indeed from total extinction. The green sector of the spectrum in the wavelength range from 500 mμ to 560 mμ was also conspicuous. Though the blue sector showed an enhancement relatively to the green as compared with what is observed with white light, nevertheless the green sector of the spectrum as seen through the instrument was not less luminous than the blue.

Numerous other examples of blue silk were examined spectroscopically. In all cases, the yellow of the spectrum was powerfully absorbed and indeed except in the case of one sample which was of a light blue colour, it was quite inconspicuous. The red of the spectrum was also much weakened but never actually extinguished. The brightness of the green sector relatively to that of the blue sector varied from specimen to specimen. It could be stated as a general rule that the deeper the colour of the silk, in other words, the more nearly it approaches an indigo colour, the less was the intensity of the green sector relatively to that of the blue.

It is evident from these studies that an elimination, more or less complete, of the yellow sector of the spectrum is essential for the perception of a blue colour. Equally essential is a substantial reduction in the luminosity of the red sector. The part played by the green sector is less obvious. That a saturated blue colour is observed even though the green and red are conspicuously present in the spectrum can scarcely be reconciled with the assumption that the sensory impressions produced by polychromatic radiation represent a simple summation of the visual sensations excited by the different parts of it. Indeed, what we actually observe may be described as a masking of the visual sensations excited by the red and green sectors by that of the blue sector. It has, however, to be recognised that the progressive elimination of

the green sector by absorption results in the observed blue colour assuming a deeper hue.

The Sensation of Red.—A bright red colour frequently appears in the gorgeously coloured silk sarees for which Bangalore is famous. It was, therefore, possible for the author to examine numerous specimens of red silk spectroscopically. They all exhibited a remarkable effect, *viz.*, a dark absorption band covering the yellow of the spectrum and separating the red from the adjoining green in the spectrum. If the absorption band is absent, the colour of the silk is not red but either scarlet or orange as the case may be, depending on the proportion of yellow light escaping from the material. If, on the other hand, the absorption extends towards greater wavelengths, the colour of the silk is a darker red.

It is evident from these observations that the extinction of the yellow in the spectrum is an essential requisite for the material to exhibit a red colour. But what is particularly remarkable is that all the specimens examined exhibit the green and blue sectors in their spectra though with enfeebled intensity. It would appear that in these cases the sensation excited by the red sector of the spectrum results in a masking of the effects of the green and blue sectors by reason of their lower intensities.

The Sensation of Green.—Silk which has been dyed green exhibits a whole range of colours varying from what may be described as a light green at one end to a deep green at the other. Spectroscopic examination reveals that the appearance of even a light shade of green is accompanied by a weakening of both the blue and red sectors of the spectrum. Noticeable also is a fall in brightness of the range of wavelengths between 560 mμ and 600 mμ relatively to the wavelength range between 500 mμ and 560 mμ, in consequence of which the maximum of luminosity in the spectrum shifts visibly towards smaller wavelengths. These features are all accentuated in the case of the specimen exhibiting deeper colours, so much so that silk which appears a full green shows a nearly complete extinction of the yellow of the spectrum and the maximum of luminosity appears at 530 mμ. Silk which is of a deep green colour exhibits the maximum of luminosity at 525 mμ and the fall of the luminosity with increasing wavelength beyond 550 mμ is so marked that a dark band separating the green and the red in the spectrum is clearly recognisable. The blue of the spectrum is very weak and may be perceived extending beyond

the green towards shorter wavelengths. The red of the spectrum is also weakened but remains a conspicuous feature in the spectrum of even the darkest green silk. But it does not exert any observable influence on the perceived colour.

We may sum up by stating that an extinction of the yellow sector of the spectrum is essential for the material to exhibit a green colour. The red of the spectrum continues to be observable but is masked from perception by the more luminous green.

The Blue-Green Sequence.—Silk may be dyed so as to exhibit a whole range of colours which may be described as intermediates between green and blue. Spectroscopic examination reveals certain features common to the whole sequence and other features which exhibit a regular progression in the series. The common feature of the whole range of colours is a large fall in the brightness of the red sector as well as a practically complete extinction of the yellow sector. The progressive feature is the extension of the spectrum towards shorter wavelengths and the increase of the intensity of the blue sector. Remarkably enough, however, in all these cases, the green sector of the spectrum as observed through the instrument appears much more luminous than the blue.

Rose-Coloured Silk.—Of exceptional interest is the case of dyed silk which exhibits a rose-red hue which is both brilliant and attractive. Spectroscopic examination reveals that this colour has its origin in an extinction of the green sector of the spectrum, while the rest of the spectrum including, especially the blue sector, remains of undiminished intensity. That the colour resulting from this extinction of the green of the spectrum is a brilliant rose-red is a particularly significant fact. It presents us with a clear-cut contradiction of the ideas of the trichromatic theory according to which the sensation resulting from a suppression of the green in the spectrum should have been a highly saturated purple.

The Theory of Colour Perception.—The facts of observation set out above and in the preceding chapter enable us to form fairly clear ideas regarding the nature of the relationship which exists between the spectral character of polychromatic radiation and its perceived colour. It is also possible to go further and to venture upon an interpretation of the facts, basing ourself on a recognition of the corpuscular nature of light and the part that it plays in the percep-
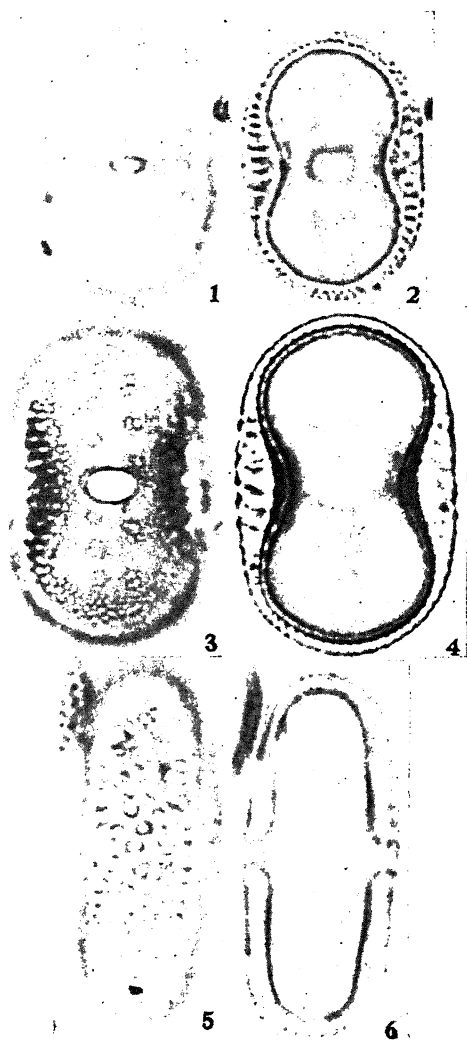
tion of the colours of monochromatic radiation.

The spectrum of white light presents to our vision a continuous progression of colour in which we can distinguish a great many different hues. At some points in the spectrum, the progression of colour is exceptionally rapid and at others it is relatively slow. These experiences become intelligible when it is recalled that the energy associated with a light corpuscle increases progressively from one end of the spectrum to the other and that the perception of light arises from the absorption of the energy of the corpuscle and its transformation in the retina into the energy of electrical impulses which travel to the centres of perception. The variations of the luminous efficiency of radiation and of the power of colour discrimination in the spectrum arise as consequences of the spectroscopic behaviour of the visual pigments in the retina. Further, each different colour which we can perceive in the spectrum is "a fundamental visual sensation" and can claim recognition as such equally with every other colour in the spectrum.

It is the conjoint effect of the sensations excited by all individual parts of the spectrum of polychromatic radiation that determines its colour. By reason of the varying luminous efficiency of radiation in the spectrum, these individual contributions differ greatly, apart from the variations determined by the varying absorption in the material. Some sections in the spectrum may therefore be expected to contribute to the visual effect much more than others. In earlier chapters, factual evidence has been presented that the major visual sensations are those associated with the yellow sector of the spectrum. It is therefore not at all surprising and indeed could have been confidently anticipated that the removal of the yellow sector from the spectrum would result in notable chromatic effects and that the presence or absence of that sector would be the principal determining factor for the observed colour of the light. This, indeed, is what we actually find to be the case.

It is convenient in considering the colour sensations excited by polychromatic radiation to consider its spectrum to consist of four sectors : the blue sector from 400 mμ to 500 mμ ; the green sector from 500 mμ to 560 mμ ; the yellow sector from 560 mμ to 600 mμ and the red sector from 600 mμ to 700 mμ. We may ask ourself, what would be the result of removing the yellow sector from the spectrum of white

undulating and appears to be formed by the amalgamation of branched bacula (their bases free, forming a supporting layer). Nexine homogeneous, inner margin smooth.

FIGS. 1-6. Figs. 1-2. *Justicia prostrata* (Cl.) Gamble × 2,000. Fig. 1. Surface view of the pollen grain showing pore, faint colpus and insulæ in the trema area. Fig. 2. Optical section. Figs. 3-6. *Rungia repens* Nees, × 1,500. Fig. 3. Surface view of the pollen grain showing pore, faint colpus, insulæ in the trema area and bacula in the peripheral area. Fig. 4. Optical section. Fig. 5. E₂ view showing bacula and punctæ. Fig. 6. Optical section.

Rungia repens Nees (Figs. 3-6).—Pollen grains 2-porate (there is an indication of a faint colpus at each aperture), bilateral (39 × 25 × 19 μ); membrane sparsely granular.

Pores lalongate (about 3 × 4 μ).

Exine about 3 μ thick at poles, up to 6 μ at equator. Sexine about 1·5 μ thick at poles, 4 μ at equator, punctitegillate in the peripheral area. Tegillum about 0·5 μ thick, slightly undulating, supported by bacula. Bacula branched at the apex and gradually shorter towards apertures.

Trema area longitudinal (25 × 12 μ), studded with circular, finely reticulate insulæ (diameter about 2–3 μ), which coalesce towards the poles. Nexine homogeneous, inner margin smooth.

I am very grateful to Prof. M. R. Suxena, for his encouragement and keen interest.

Botany Department,   BHOJ RAJ.
Osmania University,
Hyderabad, A.P., *December* 7, 1964.

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'LOOP-FORMATION' IN *HETEROTHRIX ULOTRICHOIDES* PASCHER

THE occurrence of genus *Heterothrix*, a member of the Xanthophyceæ, was first recorded in India by the authors.[3] On further examination of the species *Heterothrix ulotrichoides*, an unknown interesting morphological feature was seen. It is being described here.

It was found that, at times, an intercalary cell divides longitudinally in a plane parallel to the long axis of the filament, thus producing two daughter cells in the same transverse plane (Fig. 1). The two daughter cells then undergo repeated transverse divisions (Fig. 2) in the usual manner. The two rows of cells thus produced in intercalary position remain connected with the main filament on both sides. In this way, a small 'loop' with a diamond-shaped or elongate vacant area, surrounded by rows of cells on either side, is produced. Further continued transverse divisions may produce 'loops' of much larger size (Figs. 3-5). Sometimes, growth in the two arms of the 'loop' is unequal so that the resulting 'loop' is asymmetrical.
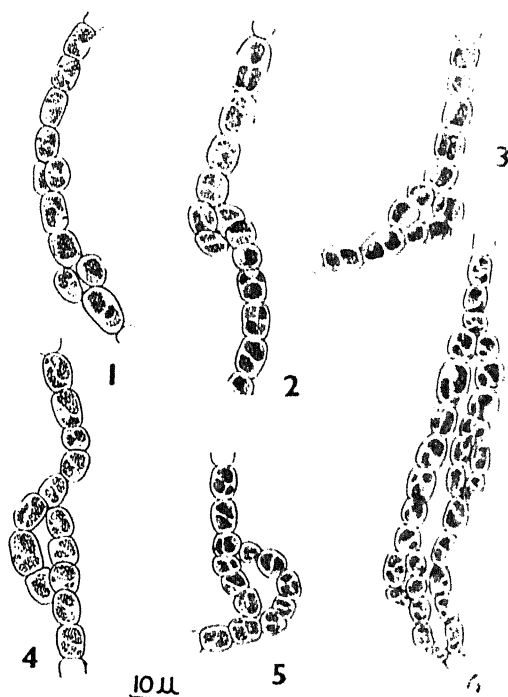
Occasionally, the process may be repeated in one or both arms of an existing 'loop' (Fig. 6). These on further growth, may ultimately produce a net-like appearance of an originally uniseriate, filamentous, unbranched alga.

'Loop-formation' has been recorded in certain members of the Ulotrichales, e.g., *Uronema*. Similar stages formed by longitudinal division are also known to occur in *Tribonema intermixtum, T. vulgare, Bumilleria Klebsiana*, etc. It is of interest to note that members of families

FIGS. 1-6. *Heterothrix ulotrichoides* Pascher. Fig. 1. A portion of a filament showing longitudinal division to cells, forming the initial stage in 'loop' formation. Fig. 2. Another filament showing transverse divisions in the two cells formed after longitudinal division. Figs. 3-5. Filaments showing stages in 'loop' formation. Fig. 6. A filament showing formations of secondary 'loop' in the two arms of an older 'loop'.

Ulotrichaceae and Heterotrichaceae which are believed[1] to show parallelism in evolution, exhibit similarity in this feature also.

Department of Botany,   BRAJ NANDAN PRASAD
Lucknow University,   P. N. SRIVASTAVA
December 7, 1964.

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YELLOW MOSAIC OF *ACALYPHA INDICA* L. A NEW WHITE FLY TRANSMITTED VIRUS DISEASE FROM INDIA

Acalypha indica a common garden weed of Delhi has often been found to be affected with a disease the symptoms of which suggested it to be due to a viral nature. The disease is very widespread and almost all plants seen were found to be affected.

The symptoms of the disease as observed in nature consist of vein clearing in the early stages and this is soon followed by small yellow spots which increase in size with age. The yellow spots coalesce and produce a more or less typical chlorosis. The mottling of contrasting yellow and green areas becomes prominent as the plant grows older (Fig. 1). In severely infected cases, the leaf size is very much reduced and the affected leaves at times become badly malformed (Fig. 2). In external appearance these leaves bear close resemblance to those of a species of bean (*Dolichos lablab* L.)

Figs. 1-2. Fig. 1. A plant of *Acalypha indica* showing typical symptoms of yellow mosaic virus. Fig. 2. Healthy and infected leaves of *Acalypha indica* showing yellowing, mottling and reduction in the size of lamina.

The disease is easily transmissible by grafting and the incubation period varies from 9 to 16 days. It is also transmitted by *Bemisia tabaci* Gen. and the time taken for typical symptoms to develop on inoculated plants ranges from 12

Such a study has been undertaken in the Applied Studies Section of the Space Surveillance and Instrumentation Branch at Rome Air Development Center (RADC). In a preliminary Report to acquaint the workers in the area of plasma physics with a new and promising plasma diagnostic technique, the Study Group has presented the theory correlating the Raman intensity with the specie density and temperature, along with experimental technique and results so far achieved. (*Technical Documentary Report, RADC-64-5.*)

New Laser Material for Automatic Giant Laser Pulses

Westinghouse research scientists have produced a new laser material that automatically generates giant pulses of laser light. Ordinarily, what is known as giant-spike operation for laser emission is achieved by means of complicated optical apparatus placed outside the laser. Now, a new kind of glass laser material developed in the Westinghouse Laboratories enables such giant spikes of energy to be produced within the laser rod itself.

The giant-spike material is a modified form of neodymium glass which is itself well known for its laser action. Ordinary neodymium glass is simply a special high-quality glass to which has been added a small percentage of neodymium ions. This impurity ion is what causes the glass to lase.

In the modified neodymium glass a small amount of uranium in the form of uranyl (UO_2^{++}) ions is added. During 'pumping' both the neodymium ions and the uranyl ions absorb energy. The absorption of the uranyl ions holds back the laser action of the neodymium. This delay allows time for many more neodymium ions to be pumped to their higher energy level before the laser burst occurs.

For the burst to take place, the greater number of inverted neodymium ions finally overcomes the delaying action of the uranium. The laser fires as a giant spike of high power and short duration, with the uranyl ions acting as a sort of built in timer that turns the laser action on at just the right instant. When done externally, this delaying and releasing is known as Q-switching. In the present case the neodymium uranyl rod switches itself.—(*Westinghouse News.*)

Quasi-Stellar Radio Sources as Spherical Galaxies in the Process of Formation

The quasi-stellar radio sources are the brightest objects known. The energy radiated by the quasar 3 C 48 has been estimated as 2×10^{46} erg/sec. One therefore asks if there is a phase in the evolution of a galaxy characterized by such a luminosity. It has been pointed out that, very early in the life of a galaxy, the gas density and therefore the rate of star formation would be high. Shklovsky estimated an absolute magnitude of -23 (minus 23) due to supernovæ alone.

Following Shklovsky's suggestion, G.B. Field of the Princeton University Observatory; has studied the earliest phases in the life of a galaxy, and calculated the properties of a galaxy forming from an intergalactic gas cloud. If a cloud of 10^{11} suns is formed with sufficient angular momentum to prevent the formation of a "massive object", but too little to permit the formation of a disc, a period of vigrous star formation is expected. Rough estimates of the phase of the commencement of star formation yield radii and velocities in the vicinity of those of the quasi-stellar sources. It is found that the radiation emitted by the young stars in such a system is of the order required in the quasars.

The crucial point is the suddenness of star formation associated with the rapid rise of gas density in the contraction of a slowly rotating system.—(*Astrophys. Jour.*, 1964, 140, 1434.)

Endeavour Prizes

Imperial Chemical Industries Limited, Publishers of the International Scientific Review *Endeavour*, award prizes totalling 100 guineas for essays submitted on any one of the following subjects: (1) Physics of the Moon, (2) Physiological basis of memory, (3) Molecular sieves, (4) Chemicals from oil, (5) Mechanisms of enzyme action and (6) Strength of materials.

The competition is restricted to younger scientists, whose twenty-fifth birthday falls on or after 1st September 1965. Only one entry is permitted for each competitor. The essay, which must be in English and typewritten, should not exceed 4,000 words in length and should reach the undersigned before 1st June 1965. The Deputy Secretary, British Association for the Advancement of Sciences, 3 Sanctuary Buildings, Great Smith St., London S.W. 1.

THE NEW PHYSIOLOGY OF VISION

Chapter XVII. Location of Visual Pigments in the Retina

Sir C. V. RAMAN

WE proceed to consider the significance of the results of our studies on the chromatic responses of the retina and to view them in the light of the conclusions regarding the identity and spectroscopic behaviour of the visual pigments arrived at in earlier chapters. For this purpose, it is necessary to summarize the results of those studies. As has already been explained, what the observer notices when he views a brightly illuminated screen through a colour filter and then suddenly removes the filter depends very much on the spectral region in which the absorption by the filter is manifested and hence differs from filter to filter.

On the basis of the observed phenomena, the part of the visible spectrum in which the absorption by the filter is effective may be placed in any one of the following four divisions, viz., I. from 4000 to 5000 A.U.; II. from 5000 to 5600 A.U.; III. 5600 to 6000 A.U. and IV. from 6000 to 7000 A.U. These regions will, in what follows, be referred to as the blue, green, yellow and red sectors of the spectrum, these being the colours which are dominant respectively in these four regions. The picture of the retina as perceived by the observer following the removal of the filter may likewise be divided into three regions. A. the fovea, B. a circular area surrounding the fovea and having a well-defined margin and a diameter about four times that of the fovea, C. The surrounding field. The luminosity and colour exhibited by these regions are related to the spectral region of absorption by the filter in a clearly definable fashion. We may indeed say that the part or parts of the spectrum in which the absorption by the colour filter appears determines the picture seen of the retina in all its details.

By far the most spectacular effects are those observed with the colour filters of which the absorption completely covers the yellow sector of the spectrum. Indeed, the phenomena observed with such filters are altogether different from those observed with the filters which exhibit absorption exclusively in the blue, green or red sectors. The striking feature exhibited by them is the manifestation of the fovea as a luminous disk conspicuous by reason of its brightness which much exceeds that of the surrounding areas. Surrounding the foveal disk and of a lesser brightness, but nevertheless clearly differentiated from the outer parts of the field is a circular area having a diameter about four times greater than that of the fovea. These features are not observed when the filters employed have an absorption lying exclusively in the blue, green or red sectors.

Thus, the observations with the colour filters demonstrate that the yellow sector of the spectrum stands in a class by itself and that it plays a highly significant role in the phenomena of vision. The same conclusion has already been arrived at and stated in earlier chapters on the basis of other considerations. But the new result which now emerges is that the visual pigment which enables us to perceive light appearing in the yellow sector of the spectrum is concentrated in the foveal region of the retina and in the areas immediately surrounding it. Only on that basis is it possible to understand the facts of observation.

The distributions in the retina of the visual pigments which enable us to perceive the blue, green and red sectors of the spectrum are clearly of a different nature. This is made evident by the picture of the retina which is seen when the filter made use of has its absorption in one or another of these three sectors. The glow exhibited by the area of the retina under observation (blue, green, red in colour as the case may be) in the areas surrounding the fovea is of uniform brightness. The fovea itself presents a different appearance in the three cases. With the filters which have a cut-off in the blue, the fovea does not exhibit the blue glow but is seen as a disk with a sharply defined edge and of a pale yellow colour. Likewise, with the filters having a cut-off in the green sector of the spectrum, the fovea does not exhibit the glow seen outside of it, but is seen dimly with a bluish tinge. In the case of the filters having a cut-off in the red, the glow seen elsewhere covers the fovea as well.

Thus, a systematic survey of the retina with the aid of colour filters exhibiting absorption in

that the students may even be tempted to copy them. They are however intended for guidance only and should be followed in the practical study according to the advice for students given by the author in the first two pages of the book.

The book is beautifully produced and if the succeeding volumes keep up the present standard, there is no doubt that the set will become an indispensable acquisition to teachers and students of botany.   A. S. G.

Features of Afro-Alpine Plant Ecology. By Olov Hedberg (Acta Phytogeographica Succica 49) (Almqvist Wiksells Poktryckeri AB., Uppsala), 1964. Pp. 144.

The author Olov Hedberg is well known for his earlier contributions on the taxonomy and ecology of the Afro-Alpine vegetation. Inhabiting an extreme environment, the Afro-alpine region is poor in species and the author earlier recognised 230 taxa as regular members of the Afro-alpine flora in tropical East Africa. A fuller phytogeographical account of this flora was deemed impracticable on account of the absence of detailed data of the life-forms of some of these plants and their adaptation to Afro-alpine climate. The present work under review claims to provide such data.

The book contains chapters on Afro-alpine environment, adaptive trends in the Afro-alpine flora, Afro-alpine life-forms, water-economy in the Afro-alpine flora and principal Afro-alpine plant communities.

The author describes primarily the macro- and micro-climate, soils, solifluction, fire and biotic influences. The wind conditions, snow and glaciers are of special interest. It is quite interesting to note the adaptive trends, *e.g.*, xeromorphy, reduction of the length of inter-nodes, etc., as an adaptation against the radiations, temperature insulation, frost heaving resistance, etc. Besides these, the life-forms such as grasses, sedges, acaulescent rossette plants, cushion plants, etc., are present along with a number of geophytes, particularly of the families Cyperaceæ, Juncaceæ, Liliaceæ and Iridaceæ; Hemicryptophytes, a few Chemæphytes and Therophytes. Though our knowledge about the alpine regions of the Himalayas is very inadequate, Olov Hedoerg's work provides us valuable information for comparative studies.

One thing that requires special mention is the concept of alpine vegetation by different authors. For comparison with other tropical mountains, the alpine zone has been defined as the zone without ligneous elements and the zone below it with dwarf shrubs as the 'sub-alpine'. Under such definition the giant forms of Lobelias and Senecios, typical of this region, hardly come under the term alpine forms.

The book which deserves to be widely read and used is useful to students and researchers of tropical mountain plants ecology.

Raj Kumar Gupta.

Books Received

Applied Mathematics and Mechanics (Vol. 8)— *Perturbation Methods in Fluid Mechanics.* By Milton Van Dyke. (Academic Press, New York), 1964. Pp. x + 230. Price $ 7.00.

Photoelectric Effects in Semiconductors. By S. M. Ryvkin (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. xv + 402. Price $ 22.50.

Ultrasound Physical, Chemical and Biological Effects. By I. E. El'piner. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. viii + 371. Price $ 22.50.

Ultrasonic Cutting. By L. D. Rozenberg, V. F. Kazantsey, L. O. Makarov and D. F. Yakhi-movich. (Translated from Russian by Lewis Balamoth). (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. xi + 142. Price $ 17.50.

Strength and Deformation in Non-Uniform Temperature Fields. Edited by Prof. Ya E. Fridman. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 169. Price $ 25.00.

Soviet Researches on Luminescence. Edited by D. V. Skobel'tsyn. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 152. Price $ 27.00.

Intensity Theory for Infra-red Spectra of Polytomic Molecules. By L. A. Gribov. (Consultants Bureau Enterprises, Inc., New York), 1964. Pp. 113. Price $ 15.00.

Structure Formation in Alloys. By Il'ya Vasil'evich Salli. (Consultant Bureau Enter-prises, Inc., New York), 1964. Pp. 140. Price $ 18.50.

International Conference on Cosmic Rays Proceedings (Vol. 3)—*Composition, Origin and Pre-history.* (Secretary, I.C.C.R., Tata Institute of Fundamental Research, Colaba, Bombay-5), 1964. Pp. 510. Price Rs. 24·00.

Guide to Gas Chromatography Literature. By A. V. Signeur. (Plenum Press, New York), 1964. Pp. 351. Price $ 12.50.

SCIENCE NOTES AND NEWS

Award of Research Degrees

The Utkal University has awarded the Ph.D. degree in Agricultural Botany to Shri B. Mishra, Central Rice Research Institute, Cuttack, for his thesis entitled "Studies in the Inheritance of Anthocyanin Pigmentation in Rice".

The Osmania University has awarded the Ph.D. degree in Physics to Shri E. Venkateswara Rao for his thesis entitled "The Vibration Spectra of Organic Molecules and Their Normal Co-ordinate Treatment".

International Conference on Luminescence

An International Conference on Luminescence, sponsored by the I.U.P.A.P. and organised by the Hungarian Academy of Sciences will be held from August 23 to 30, 1966, in Budapest.

The program will include sessions on General Theory of Luminescence; Inorganic Crystalphosphors; Organic and Amorphous Luminophors, Application of Luminescence. Further information available from Dr. G. Szigeti, Director of the Research Institute for Technical Physics of the Hungarian Academy of Sciences, Budapest, POB: Ujpest 1, No. 76, Hungary.

Indian Council of Medical Research : Award of Fellowships

The Indian Council of Medical Research invites applications (before 15th June 1965) from Medical graduates, with experience in research, for the award of Fellowships of the National Institutes of Health, U.S.A., for training in that country. Application forms and further details can be had from The Director, Indian Council of Medical Research, Post Box 491, New Delhi.

Rapid Dyeing of Wool

A method of dyeing wool developed in the Division of Textile Industry of the CSIRO, Australia, promises to be much quicker than conventional methods. The investigations (Report No. G 12) of McPhee and Hine have shown that wool can be processed at 90° C. for up to 30 minutes without significant damage if acidity is controlled within the narrow range pH 3·6–4·2. Further experiments have shown that dyeing is possible in this optimum pH range and at safe temperatures if a suitable detergent is used as dyeing assistant. The detergents evolved are polyoxy-ethylated monylphenols having 6 to 10 mols of ethylene oxide to each mole of monylphenol.

The procedure differs in details for different kinds of dyes, but in all cases total times of only about half the time for conventional dyeing are required. (*Australian Science Newsletter.*)

On the Occurrence of *Isoetes panchananii* Pant and Srivastava in Andhra Pradesh

A. N. Henry, Botanical Survey of India, 56, Lower Circular Road, Calcutta-14, writes :

Isoetes panchananii was recently described by Pant and Srivastava from Ram Nai, Rewa, Madhya Pradesh (*Proc. Ind. Acad. Sci.*, 1962, 28 B, 245). But for the type locality, this species is only known doubtfully from Panchgani, Maharashtra. The author, while undertaking botanical exploration work in Andhra Pradesh, collected this species at Pakhal Lake, Warangal District, on February 25, 1963 ; plants were seen growing luxuriantly in association with *Isoetes coromandelina* L., *Fuirena ciliaris* (L.) Roxb., *Scirpus supinus* var. *lateriflorus* (Gmelin) Koyana and *Glossostigma spathulatum* Arn., along the margin of Pakhal Lake. The occurrence of this plant in Andhra Pradesh constitutes a noteworthy distribution to South India.

Isoetes panchananii can be easily distinguished from *I. coromandelina* by adult plants being smaller and megaspores clearly reticulate.

Specimen examined : *Henry 15982*, deposited in the Southern Circle Herbarium, B.S.I., Coimbatore (MH).

New Information Services for Scientists

The volume of publication in the scientific literature has become so extensive in recent years that the individual scientist or executive can no longer keep up with this himself. To keep abreast with research publication, the largest laboratories employ graduate-staffed information departments ; for those who cannot afford this, however, a new British project operated by the Scientific Documentation Centre is supplying "Current Awareness Services". These give complete information services for laboratories without information departments ; and services on specialized topics to extend the coverage of existing information units.

Light in Persistent Daily Rhythms, by J. Woodland Hastings.

The subject-matter of Volume 2 is dealt with in ten chapters as listed below : (1) Animal Photoperiodism, by Albert Wolfson ; (2) Phototaxis in Micro-organisms, by Roderick K. Clayton ; (3) The Photoreceptor Process in Lower Animals, by Donald Kennedy ; (4) Vision as a Photic Process, by W. A. H. Rushton ; (5) The Physical Limits of Visual Discrimination, by H. B. Barlow ; (6) Studies on Ultraviolet Radiation Action Upon Animal Cells, by Arthur C. Giese ; (7) Mutagenic Effects of Ultraviolet and Visible Light, by G. Zetterberg ; (8) Photoreactivation of Ultraviolet Damage, by Claud S. Rupert ; (9) Photochemistry of the Nucleic Acids, by Kendric C. Smith ; and (10) Bioluminescence—Production of Light by Organisms, by Aurin M. Chase.   C. V. R.

Advances in Analytical Chemistry and Instrumentation (Vol. 3). Edited by C. H. Reilley. (John Wiley and Sons, Inc., 605, Third Avenue, New York, N.Y.), 1964. Pp. vii + 523. Price $ 15.00.

This series in the field of analytical chemistry is intended to present significant new ideas and techniques as well as the status of important, but more classical methods. The present volume contains the following articles : (i) Atomic Absorption Spectroscopy, by R. Lockyer ; (ii) Photometric Titration, by A. L. Underwood ; (iii) Analytical Applications of Enzyme-Catalyzed Reactions, by W. J. Blaedel and G. P. Hicks ; (iv) Ion Sources and Detectors for the Mass Spectroscopic Study of Solids, by L. F. Herzog, D. J. Marshall, B. R. F. Kendall, and L. A. Cambey ; (v) Galvanic Analysis, by P. Hersch ; (vi) Linear Elution Adsorption Chromatography, by Lloyd R. Snyder ; (vii) Concepts and Column Parameters in Gas Chromatography, by J. Calvin Giddings ; and (viii) Thin-Layer Chromatography, by Rene Maier and Helmut K. Mangold.   C. V. R.

Advances in Organometallic Chemistry (Vol. 1). By F. G. A. Stone and R. West. (Academic Press, Inc., 111, Fifth Avenue, New York-3, New York), 1964. Pp. 334. Price $ 11.00.

Of recent years the study of organometallic chemistry has grown rapidly. In particular, the subject has advanced by reason of the discovery of several classes of compounds possessing remarkable structures, by the development of valence theory which accounts for the existence of such compounds and for the nature

of carbon-metal bonds, as also by the growing use of organometallics in industrial process. The serial publication is intended to put authoritative reviews on recent developments all aspects of the subject.

The present volume contains the following chapters : (i) Diene-Iron Carbonyl Complexes and Related Species, by R. Pettit and G. Emerson ; (ii) Reactions of Organotin Hydride with Organic Compounds, by Henry G. Kuivila (iii) Organic Substituted Cyclosilanes, by Henry Gilman and Gerald L. Schwebke ; (iv) Fluorocarbon Derivatives of Metals, by P. M. Treichel and F. G. A. Stone ; (v) Conjugate Addition of Grignard Reagents to Aromatic Systems, by Reynold C. Fuson ; and (vi) Infrared and Raman Spectral Studies of π Complexes Formed between Metals and C_nH_n Rings, by Heinz P. Fritz.

C. V. R.

Tacheometric Tables (Fourth Impression). By F. A. Redmond. (Asia Publishing House, Bombay-1), 1964. Pp. 256. Price Rs. 15·00.

Tacheometry is an advanced form of surveying, useful in many ways. If it is not as popular as it should be, it is because of the tedious labour associated with the process of reducing the readings. The present Tables, first published in 1951, were intended to remove this handicap and thus promote the practice of tacheometry by surveyors. The original compilation was the result of painstaking and devoted task extended over three years by the author.

That a fourth reprint of the Tables has been called for shows that tacheometric survey is gaining ground ; it also vouchsafes for the accuracy of the data compiled here.

The Tables give the horizontal and vertical distances required by the surveyor from staff intercepts read into a Tacheometer. The angle range from 0° to 20° by 20' intervals and distances range from 50 to 850 ft. The ten-page introduction explains the fundamental formula involved and the use of the Tables.

A. S. G.

Handbook of Manures and Fertilisers. (Indian Council of Agricultural Research, New Delhi) 1964. Pp. 333. Price Rs. 6·50.

The present need for concentrating all effort at increasing agricultural production in the country cannot be over-emphasized. It is necessary in this context that scientific knowledge gained through research and experimentation should be brought home to the farmers and growers who are actually engaged

in the fields. The task is not an easy one as traditional methods of cultivation have generally a greater appeal and innovations are looked upon with doubt. In fertilizer practice, for example, it is important that organic manures and chemical fertilizers should be used more discriminately and less routinely. Excessive or indiscriminate or untimely use may not yield the expected results. The several agencies employed by the government for educating the farmers in the use of fertilizers by practical and convincing demonstrations have a responsible duty to perform. The compendium which is a co-operative work of experts has been prepared by the Indian Council of Agricultural Research, New Delhi, and deals in a precise manner with all aspects of manuring and use of fertilizers and nutrients applicable to different crops grown in India. The principles discussed and the presentation of the materials are such that the book is sure to have even a wider appeal.

A. S. G.

International Conference on Cosmic Rays—Proceedings.

Volume 1 : *Solar Particles and Sun-Earth Relations*. Pp. 265. Price Rs. 20·00.
Volume 2 : *Modulation*. Pp. 470. Price Rs. 30·00.

The Eighth International Conference on Cosmic Rays was held in Jaipur, India, from December 2-14, 1963. The Proceedings of the Conference are being published in six volumes. We had occasion to review the two volumes 4 and 5 that had come out earlier (*Curr. Sci.*, 1964, 33, 478 and 693). Volume 1 contains 23 papers contributed by 35 authors and Vol. 2, 59 papers contributed by more than 100 authors.

Copies can be had from the Organizing Committee, c/o. Tata Institute of Fundamental Research, Colaba, Bombay-5 (BR) (India).

Atoms, Molecules and Quanta (Vols. 1 and 2). By A. E. Ruark and H. C. Urey. (Dover Publications, 180, Varick Street, New York-14, N.Y.), Pp. xvi + 447. Price $ 2.50 ; Pp. 448-810. Price $ 2.50.

Ever since its first publication 35 years ago the book *Atoms, Molecules and Quanta* by A. E. Ruark and H. C. Urey, more familiarly known as only "Ruark and Urey", remained for over two decades as a favourite text-book with students and teachers of advanced physics. The book is concerned essentially with extra-nuclear properties of isolated atoms and molecules, and

their interaction with radiation and bombarding particles—mainly on a non-relativistic basis.

The book still remains as one of the best on the subject with its clear exposition of the vital theories and experiments connected with atomic and molecular physics.

Originally intended for post-graduate and research students, the contents of the book are mostly covered now in the first years of the graduate courses in physics. Hence there is a need for a low-priced edition and the Dover paperbacks meet this demand.

The Dover reprint which appears in two handy volumes has been emended by the authors and contains supplementary notes at the end which bring the references more up-to-date. A. S. G.

Books Received

Molecular Complexes in Organic Chemistry. By L. J. Andrews and R. M. Keefer. (Holden-Day, Inc., San Francisco), 1964. Pp. viii + 196. Price $ 8·75.

Absolute Stability of Regular Systems (Translated by E. Polak). By M. A. Aizerman and F. R. Gantmacher. (Holden-Day, Inc., San Francisco), 1964. Pp. 172. Price $ 8.95.

Dynamic Stability of Elastic Systems. By V. V. Bolotin. (Holden-Day, Inc., San Francisco), 1964. Pp. xii + 451. Price $ 12.95.

Advances in Ecological Research (Vol. 2). Edited by J. B. Cragg. (Academic Press, Inc., London Ltd., Berkeley Square House, London W. 1), 1964. Pp. xi + 264. Price 57 *sh.* 6 *d.*
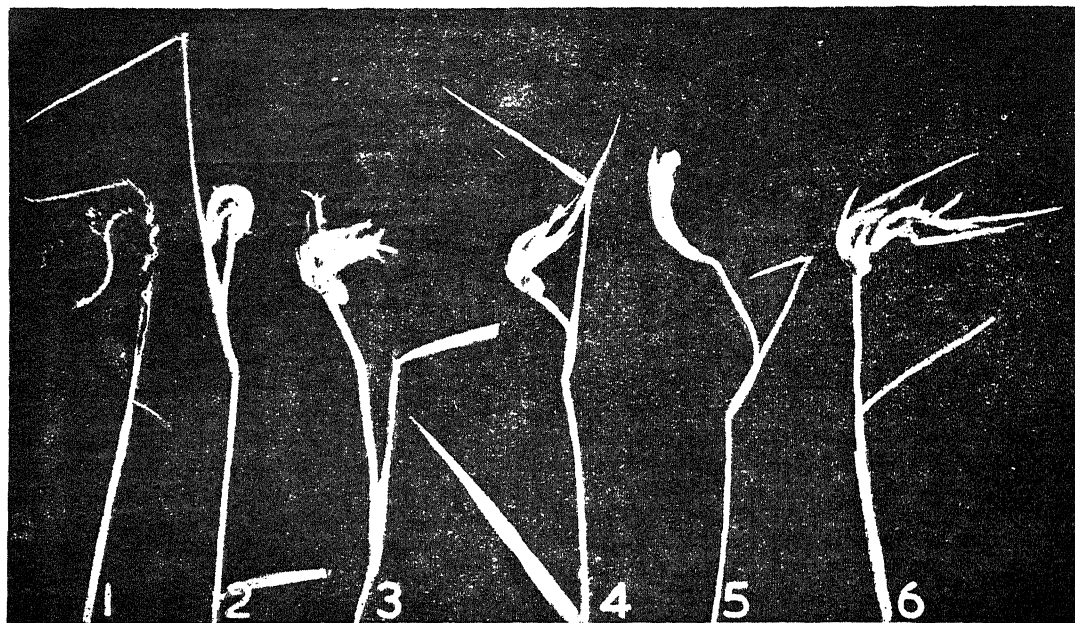
The Natural History of Aggression—Institute of Biology Symposium No. 13. Edited by J. D. Carthy and F. J. Ebling. (Academic Press, Inc., London Ltd., London W. 1), 1964. Pp. vi + 159. Price 30 *sh.*

The Arlington Practical Botany (Book I)—*Plant Anatomy*. By Mary-Anne Burns. (Arlington Books, 15 Duke Street, London S.W. 1), 1965. Pp. 93. Price 15 *sh.*

Progress in Astronautics and Aeronautics (Vol. 14). Edited by Victor G. Szebehely (Academic Press, New York), 1964. Pp. xix + 744. Price $ 10.75.

The Red Blood Cell—A Comprehensive Treatise. Edited by C. Bishop and D. M. Surgenor (Academic Press, New York), 1964. Pp. xiv + 566. Price $ 17.00.

Evaluation of Drug Activities (Vols. I and II). By D. R. Laurence and A. L. Bacharach. (Academic Press, Inc., London Ltd., London W. 1), 1964. Vol. I : Pp. xvii + 456. Price 90 *sh.* ; Vol. II : Pp. vii + 457-900. Price 95 *sh.*

FIGS. 1 6.   Fig. 1. Infected inflorescence showing the usual symptoms of smut, all the four fascicles are linear and have been turned into smut sori.   Fig. 2. One of the fascicles is hypertrophied and has turned into a gall, while the other fascicles are reduced but do not show smut sori.   Fig. 3. The tip of the inflorescence axis bearing four galls; the glumes covering the galls are differentiated into the sheath and the lamina.   Fig. 4. Three galls at the tip of inflorescence axis.   Fig. 5. The entire inflorescence is represented by one elongated gall.   Fig. 6. Four galls at the tip of the inflorescence axis; the sori are dehiscing.

one elongated gall. It consists of a mass of spores covered by the host tissue.

The spores in these galls are around 7μ in diameter and show a smooth and thick episore, as is typical of *Ustilago cynodontis*.[4]

I am grateful to Professor P. Maheshwari for interest and encouragement.

Department of Botany,   HARDEV SINGH.
University of Delhi,
Delhi-7, *November 16, 1964.*

1. Chevalier, L., *Nat. Monspeliensia, Sér. Bot.*, 1960, **12, 3.**

2. Chona, B. L., Lall, G. and Kakria, N. C., *Indian Council Agric. Res.*, New Delhi, 1958, Bull. No. **81.**

3. Mehta, K. C., *J. Indian. bot. Soc.*, 1923, **3, 243.**

4. Mundkur, B. B. and Thirumalachar, M. J., *Ustilaginales of India*, C.M.I., Kew, 1952.

Acoustics—Principles and Methods. by Warren P. Mason. (Academic Press, 1, Fifth Avenue, New York-3.)

l, Part A—*Methods and Devices.* Pp. .5. Price $ 18.00.

., Part A—*Methods and Devices*, 1964. + 376. Price $ 13.50.

ulti-volume work is intended to provide ated treatment of the techniques, appli- nd analytical results obtainable by the uysical acoustic methods. It describes luency sound waves in gases, liquids, s, and their uses as tools for analyzing cular, defect, domain wall, and other motions that can occur in these media.

high amplitude waves in these media described in their device applications, such uses as delay lines for storing on, mechanical and electromechanical r separating communication channels, : cleaning, testing inspection, measur- hining, welding, soldering, polymeri- omogenizing, medical diagnosis, sur- . therapy.

: 1, Part A, covers the propagation of nal and finite waves in fluids and olids, modifications caused by bound- nsducers required to generate low and litude waves, and methods for measur- properties of such waves. Their uses -sive and non-dispersive delay lines, nical and electromechanical filters, and ntrol of the frequencies of oscillators standards are also presented.

: 1, Part B, deals with low and high e uses of acoustic waves in inspection :essing. Methods for producing and hypersonic waves by means of piezo- semiconductors and cavity resonators ibed. High frequency devices produced onductor transducers of the depletion ffusion layer, or epitaxial layer type ented in their device applications and undamental investigation of very rapid .d solid state motions.   C. V. R.

Differential Equations of Mathematical s, Vol. 1. By Tychonov and Smarski. ated by S. Radding. (Holden-Day, Inc., rancisco, California), 1964. Pp. 380. ; 11.75.

ext provides a thorough treatment of al differential equations of mathemati-

cal physics. The canonical forms of these equations are first derived and then followed by a discussion of their principal features. The study of each type of equation is motivated by its physical origins and the various methods for its solution are presented. The relations between some of these methods are also demonstrated. The questions of existence and uniqueness of the solution of an initial value or boundary value problem are carefully stated, together with their physical significance.

Each chapter contains worked-out examples which are drawn from different disciplines, and a wealth of problems to emphasize the methods developed. The text should appeal to the university students of mathematics, physics, engineering and chemistry, as well as to those who desire to be self-taught. It is unique in providing a smooth transition from the undergraduate level to the more advanced treatises of partial differential equations. It should also be welcomed by the experts as a convenient reference text.   C. V. R.

The Proteins : Composition, Structure and Function, Second Edition, Vol. 2. Edited by Hans Neurath. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 802. Regular Price $ 26.00 ; Subscription Price $ 24.00.

The first volume of the second edition of this treatise was reviewed in *Current Science* in September 1964. The second volume is contiguous with the first, since it deals with the fundamental properties of proteins, both in solution and in the solid state. It contains five long chapters of which the authors and the subjects dealt with by them are the following. John A. Schellman and Charlotte Schellman have written on the conformation of polypeptide chains in proteins ; Jacinto Steinhardt and Sherman Beychok discuss the interaction of proteins with hydrogen ions and other small ions and molecules. The behaviour of interacting protein systems is dealt with in detail by L. W. Nichol, J. L. Bethune, G. Kegeles and E. L. Hess. Polyamino-acids considered as protein models are surveyed by E. Katchalski, M. Sela, H. I. Silman and A. Berger. The final chapter in the volume by Richard E. Dickerson on the X-ray analysis of protein structure presents a timely and penetrating account of a field of study which it is hoped will lead to the

have received renewed attention because of progress in their solution by machines. This volume undertakes a definition of the field, indicating advances that have been made up through 1960.

Applied Group-Theoretic and Matrix Methods. By Bryan Higman. Pp. 544. Price $ 2.50.

In part one, the author presents an easily followed discussion of the elementary theory of finite groups, covering such abstract finite groups as cyclical, dihedral, permutation, and S-groups. This is followed by accounts of matrix algebra, complex and hypercomplex numbers, and conjugation and equivalence. In this part there is also a chapter on group representations. In part two, applications of finite groups are treated. A discussion of internal and external crystal structure precedes a chapter devoted to the subject of the vibrations of molecules. The problems of factor analysis are also touched upon.

Introduction to Applied Mathematics. By Francis D. Murnaghan. Pp. 383. Price $ 2.00.

The author covers in detail vector and matrix analysis, partial differential equations, integral equations, calculus of variations, Laplace transform theory, linear vector functions, quadratic bilinear forms, Fourier series, orthogonal curvilinear co-ordinates in the plane and in space, Laplace's equation, problems in electrostatistics, the method of separation of variables, the methods of inversion, spherical harmonics, Bessel functions, boundary-value problems, self-adjoint linear differential operators, Green's function as a linear integral operator, boundary-value problems of partial differential equations, the Fredholm determinant, the solution of integral equations, Rayleigh's principle, the action integral, the convolution process, the Heaviside expansion formula, and other important topics.

<div align="right">C. V. R.</div>

Books Received

Simultaneous Rapid Combustion Microchemical Research Papers of Mirra Osipovna Korshun. Edited by J. A. Kuck. (Gordon & Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. xv + 560. Price $ 27.50.

Tacheometric Tables (Fourth Edition). By F. A. Redmond. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1964. Pp. xx + 256. Price Rs. 15·00.

The Physical World, An O Level Course (Vol. I) —*Mechanics.* By H. J. P. Keighley and F. R. McKim. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. xv + 223. Price 15 *sh.*

Biomedical Sciences—Instrumentation (Vol. II). Edited by W. E. Murry and P. F. Sallisbury. (Plenum Press, 227 W, 17th Street, New York, N.Y. 10011), 1964. Pp. viii + 295. Price $ 12.50.

Algœ and Man. Edited by D. F. Jackson. (Plenum Press, New York, N.Y.), 1964. Pp. x + 434. Price $ 14.50.

A Systematic Classification of Types of Intermetallic Structures. By P. K. Kripyakevich. (Plenum Press, New York, N.Y.), 1964. Pp. 35. Price $ 10.00.

Archimedes in the Middle Ages (Vol. I)—*The Arabo-Latin Tradition.* By M. Clagett. (The University of Wisconsin Press, Madison, Wisconsin), 1964. Pp. xxix + 720. Price $ 12.00.

Advances in Cancer Research (Vol. VIII). By A. Haddow and S. Weinhouse. (Academic Press, 111, Firth Avenue, New York), 1964. Pp. viii + 482. Price $ 17.00.

Star Names, Their Lore and Meaning. By R. H. Allen. (Dover Publications, 180, Varick Street New York-14), 1964. Pp. xiv + 563. Price $ 2.35.

The Friendly Stars. By M. E. Martin. (Dover Publications, 180, Varick Street, New York-14), 1964. Pp. 147. Price $ 1.00.

The Sources of Science No. 4—Animal Chemistry. By J. Leibig. (Johnson Reprint Corporation, New York), 1965. Pp. x + 347. Price $ 15.00.

Organic Chemistry. By Hans Beyer. (Asia Publishing House, Bombay-1.) Pp. xv + 761. Price not given.

The Chemical Society Special Publication No. 17 —The Chemical Stability Constants of Metal Ion Complexes. (The Chemical Society, Burlington House, London W. 1), 1964. Pp. xviii + 754. Price £ 8-0-0 or $ 23.00.

Advances in Marine Biology (Vol. II). By F. S. Russell (Academic Press, Berkeley Square House, London W. 1), 1964. Pp. x + 274. Price 57 *sh.* 6 *d.*

SCIENCE NOTES AND NEWS

Award of Research Degree

Andhra University has awarded the D.Sc Degree in Geophysics to Sri. B. Padmanabha Murty and Sri. C. Radhakrishna Murty for their theses entitled "Some Aspects of Moisture Balance in Micrometeorology" and "Remanent Magnetism of the Igneous Rocks in the Gondwana Formation of India" respectively.

Device for Detection of Polar Vapours in Gas Chromatography

A new device to detect polar vapours, installed in gas chromatographic systems, enables discrimination between compounds by differences in polarity. The difference is measured by regarding the change in contact potential caused by the physical adsorption and desorption of polar vapour on a nickel surface. The device has been used to investigate a variety of alcohols, ketones and nitro compounds.

The experimental detector cell consists of two circular plates. One is a 0·0005 inch disc of nickel foil that functions as the sensor plate and the other is a 0·002 inch disc of gold foil called the vibrating plate. The plates are separated from each other by a 0·01 inch mica spacer in such a way that vapour can be passed between them. The signal from the two plates goes to an oscilloscope. When polar vapours are adsorbed on the surface of a solid, they exchange the surface potential. This causes the contact potential of the solid to shift with respect to a less sensitive reference surface. The shift can be measured by a capacitor equipped into dissimilar plates. To cause a polar vapour to adsorb and then desorb on the nickel plate, the nickel is alternately heated and cooled. Heating is accomplished by a 6 V battery, and cooling by precooled nitrogen flowing behind the plate. n-Butanol, acetone and nitromethane have been studied and the sensitivity of the detector has been found to be 10^{15} molecules/c.c., flow rate 200 c.c./min. and response time c. 3 sec.—[Chem. Engng. News, 1964. 42, (23) 59.]

Blue Pigment of a Surface-Living Oceanic Copepod

P. J. Herring has reported from R.R.S. Discovery now cruising the Indian Ocean, some interesting preliminary observations regarding the blue pigment of plankton organisms living in ocean surfaces. Special nets have made possible collection of surface planktons in the top 4 in. of the ocean water. One of the most striking features of the living hauls is the predominance of blue pigmented organisms, and these have been seen in a wide diversity of groups, among them copepods, mysids, decapods, stomatopod larvæ, siphonophores, chætognaths, salps, diliolids and appendicularians. The most typical members of the catch are pontellid copepods, and these show a blue colour more intense than most other groups. Since blue is a colour almost completely absent in deeper living planktons it was considered to be of interest to make a closer examination of this typical feature of the tropical surface plankton. Using the surface net it was possible to capture very large numbers of Pontella fera Dana and carry out a simple analysis of its pigment extracted by grinding the animals, centrifuging the homogenate and filtering the supernatant liquid.

The blue pigment is insoluble in ether, benzene and carbon tetrachloride. Spectrophotometer curve between 400 and 1000 mμ showed a broad absorption band with a peak at about 640 mμ.

It seems probable that the pigment is a chromoprotein complex of a carotenoid and a protein. This is suggested by its initial insolubility in fat solvents, the ease by which it is denatured, particularly when pH changes occur, and the fact that peak absorption after denaturation (presumed to involve breakage of the carotenoid-protein link) is at 450–475 mμ, a region characterstic of the carotenoid pigments commonly found in planktonic animals.

The pigment appears to be uniformly distributed over the body of the animals, but there are concentration sites at the antennæ and over the ventral eye. The reason for the preponderance of blue in tropical plankton is not clear. It may be a camouflage against the predator, or a protection against the strong solar radiation to which the surface plankton is exposed in the tropics.—(Nature, 1965, 205, 103.)

A Fifth Natural Force ?

An experiment recently reported by scientists of the Brookhaven National Laboratory has called into question the concept of time-reversal invariance which has been held as a fundamental postulate in nuclear particle reactions. The experiment showed that the neutral K_2

Books Received

The Sources of Science—Experiments and Consideration Touching Colours. By Robert Boyle (Johnson Reprint Corporation, 111, Fifth Avenue, New York), Pp. xxvi + 423.

Indian Woods (Vol. II)—*Their Identification, Properties and Uses—Linaceœ to Moringaceœ.* (The Manager of Publications, Delhi), 1963. Pp. x + 386. Price Rs. 32·50.

Mossbauer Effect—Principles and Applications. By G. K. Wertheim. (Academic Press, New York), 1964. Pp. viii + 116. Price $ 2.45.

Potential Barriers in Semiconductors. By B. R. Gossick. (Academic Press, New York), 1964. Pp. x + 153. Price $ 2.45.

Elementary Dynamics of Particles. By H. W. Harkness. (Academic Press, New York), 1964. Pp. ix + 219. Price $ 2.95.

Elementary Plane Rigid Dynamics. By H. W. Harkness. (Academic Press, New York), 1964. Pp. ix + 191. Price $ 2.95.

The Chemical Society—Annual Reports on the Progress of Chemistry for 1963, Vol. LX. (The Chemical Society, Burlington House, London W. 1), 1964. Pp. vi + 681. Price $ 2.00.

Crystals—Their Role in Nature and in Science. By C. Bunn. (Academic Press, New York), 1964. Pp. viii + 286. Price $ 3.45.

Counterexamples in Analysis. By B. R. Gelbaum and John M. H. Olmsted. (Holden-Day, Inc., San Francisco), 1964. Pp. xxiv + 194. Price $ 7.95.

Ways of Thoughts of Great Mathematicians. By Meschkowski. (Holden-Day, Inc., San Francisco), 1964. Pp. viii + 110. Price : Clotn $ 5.95 ; Paper $ 3.95.

Documents on Modern Physics—Theory of Crystal Dislocations. By A. H. Cottrell. (Gordon and Breach, 150, Fifth Avenue, New York-11), 1964. Pp. ix + 91. Price : Cloth $ 4.50 ; Paper $ 2.50.

Soils of India. By S. P. Raychaudhuri, R. R. Agarwal, N. R. Datta Biswas, S. P. Gupta and P. K. Thomas. (Indian Council of Agricultural Research, Krishi Bhawan, New Delhi), 1963. Pp. vi + 496.

Pure and Applied Mathematics (Vol. XV)—*Geometry of Manifolds.* Edited by P. A. Smith and S. Eilenberg, 1964. Pp. ix + 273. Price $ 10.50.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the Ph.D. Degree in Nuclear Physics to Shri K. Pardhasaradhy for his thesis entitled "Studies on the Absolute Photoelectric Cross-Sections of Gamma Rays"; D.Sc. Degree in Nuclear Physics to Shri K. Venkata Reddy for his thesis entitled "Level Scheme and Angular Correlations of Certain Even-Even Radioactive Nuclei".

Allahabad University has awarded the D.Sc. Degree in Chemistry to Dr. Surendra Nath Sinha for his thesis entitled "Studies on Metal Chelates of Some Lanthanons in Aqueous Solution".

Indian Phytopathological Society

The 15th and 16th Annual Meetings of the Society were held on December 29 and 30, 1964 at the University College of Science and Technology, Calcutta. Prof. T. S. Sadasivan (President for 1963) and Dr. S. Sinha (President for 1964) delivered their Presidential Addresses. A symposium on "Host Parasite Relationships in Plant Diseases" and a Session for reading of scientific papers were held. Shri M. J. Nara-

simhan delivered the Second Mundkur Memorial lecture on December 29 and Academician Professor N. A. Krasilinikov addressed the Society and gave a lecture on "Soil Micro-organisms in relation to Phytopathogens" on December 30.

Gas-Liquid Chromatography to Assess Milk Quality

Experiments at the National Institute for Research in Dairying at Shinfield, Reading, Berkshire, have demonstrated that gas-liquid chromatography can be successfully used in assessing milk quality. Since this technique is easily automated it may be possible to adapt it as the basis for an automatic test at milk factories.

As is well known in gas-liquid chromatography a very small sample of the mixture is carried by an inert gas through a narrow column where it contacts a liquid phase that delays the passage of individual components for slightly different periods, thus separating them. They escape in turn *via* a detector that records the emergence of the components as a series of

on the chromatogram—each peak being :eristic for any one component.

milk turns sour due to bacterial action, in product is non-volatile lactic acid, but of volatile chemicals are also formed. amounts of these are normal constituents sh milk—souring merely alters their ts and relative proportions. The pattern is on a chromatogram of fresh milk there-ffers from the pattern produced by milk turning sour and the differences indicate r deterioration in quality has progressed. the chemical changes associated with ; are readily detectable by gas-liquid tography.

ream of nitrogen gas, passed upwards hypodermic needle into a vertical glass ntaining a 0·2 millimetre sample; causes lk to bubble up and form a film on the of the tube. The volatiles, entrained by rogen stream as it sweeps past this com-ely large area of milk, are then trapped led metal coil. When this coil is warmed :ally, the volatiles pass on into the tograph where analysis is effected in 20 seconds.—(*Brit. Inf. Serv.*)

itions in Polymer Crystals

recent discoveries that high polymers are ; of forming chain-folded lamellar single s when deposited from dilute solution, at lamellar crystals of a similar nature 'esent in many bulk polymers, have 1 interest in the growth and properties ain—folded molecular crystals. These s have been most widely studied in .ylene, but attention has been confirmed, most part, to what may be considered :ies of the *ideal* crystal. Properties sensi-defect structures within *real* crystals eceived no thorough investigation. It is that giant screw dislocations are com-present during growth and often give rise rth spirals or terraced growth pyramids, at Moire patterns occasionally reveal ; probably indicative of the presence of slocations.

contribution to the *Journal of Research* ational Bureau of Standards, H. D. Keith Telephone Laboratories, and E. Passaglia e the role that dislocations are likely to chain-folded polymer crystals, parti-with regard to their influence on plastic ition. It is assumed that primary bonds be broken in backbone molecular chains; is restriction, together with further restrictions brought about by chain-folding, limits substantially the number of permissible dislocations and glide processes. It is shown that dislocations are unlikely to play a major part in bringing about deformations of appreciable magnitude in chain-folded polymer crystals.—[*Jour. Res.* (A), Nat. Bureau Std., 1964, 68, 513.]

A New Hypothesis for the Red-Shift in the Spectra of Distant Stars

It is known that the lines in the spectra of distant stars show a red-shift which is proportional to the distance of the star from the observer. This is usually interpreted as a Doppler effect due to an assumed "expansion of the universe". Attempts have been made to explain the observed red-shift by the assumption that a photon travelling through space continually loses energy at a constant rate. Controversial opinions have been expressed as to how such a loss of energy could take place.

In a communication to *Physics Letters* (1 December 1964), R. Fürth proposes a mechanism for the loss of energy of the photons which assumes only gravitational effects on photons and leads to a numerical value for the expected red-shift of the right order of magnitude.

According to classical electrodynamics an electron, forced to move along a circular path, emits electromagnetic radiation and therefore continually loses energy or, in modern parlance, emits a very large number of low energy photons at a constant rate. Similarly one might imagine that a photon, forced to move along a curved path in a gravitational field, steadily loses energy by sending out "gravitational waves" (or emitting "gravitons").

Applying the quantum-mechanical treatment combined with the laws of electrodynamics applicable to electron, to the present case of a centripetally moving photon in a gravitational field, Fürth shows that the time dependence of the energy E of the system can be written as $E = E_0 \exp(-\epsilon l/R)$, where E_0 is the original energy of the photon on its emission from the source and l is the distance travelled by it, and ϵ a numerical constant of the order of unity. The red-shift for sufficiently small $\epsilon l/R$ will thus be $\Delta\lambda/\lambda \approx \epsilon l/R$. If it is assumed that the universe is a "closed sphere" of average curvature $1/R$, the photons travelling in such a universe will follow curved paths of this curvature, and R would then be the "gravitational radius" of the universe.—(*Physics Letters, Amsterdam*, 1964, 13, 221.)

the identification, to Dr. R. L. Mathur, Plant Pathologist, Rajasthan, for kind interest in work and to Shri T. C. Kala, Director of Agriculture, Rajasthan, for facilities.

Plant Pathology   S. P. SEHGAL.
  Section   A. L. DESHPANDE.
Sub-station, Kota   U. S. SHRIVASTAVA.
(Rajasthan), *June* 25, 1964.

GYROTHRIX CIRCINATA (BERK. AND CURT.) HUGHES, A NEW RECORD FOR INDIA

IN the course of his studies on the mycoflora of Bhopal (India), the author collected *Gyrothrix circinata*, a hyphomycetous fungus on dead portions of living leaves of *Syzygium cumini* (Linn.) Skeels, from Botanical Garden, Motilal Vigyan Mahavidyalaya, Bhopal, on 12th September 1963. *Gyrothrix circinata* has been recorded from North America, Indonesia, and Africa; here it is being presented as a new record for India.

Colonies effused, velvety, dark brown to black, 0·5–2 mm. diam., chiefly hypophyllous, scattered. Mycelium superficial, composed of a network of branched and anastomosing, smooth-walled, septate, subhyaline to light brown hyphæ bearing closely packed sporogenous cells, here and there becoming thickened and dark brown at the point of origin of the setæ. Setæ (Fig. 1) numerous, intertwined, erect, thick-walled, septate, dark brown, spinulose, circinate, 2–4 times branched, 70–120 μ high, 4–5 μ broad at the base (above the bulbous swelling) tapering to a width of 1 μ at the apices of the branches. Branching sub-dichotomous, branches paler in colour, markedly spinulose, circinate. Sporogenous cells (Figs. 2–3) borne laterally on the superficial hyphæ, obclavate to lageniform, pointed above, sub-hyaline, 6·4–8 μ high, 3–4·8 μ wide at the base. Conidia adherent, aggregated into a whitish layer at the base of setæ, cylindrical to fusoid, straight or slightly curved, with the attached end subulate and the free end bluntly corniform, continuous, hyaline, 8–13 × 1·5–2·4 μ.

The voucher specimen has been deposited in the herbarium of C.M.I., Kew, as No. 102502. The author expresses his grateful thanks to the Principal and Prof. O. N. Handoo for facilities and encouragement; to the Director and Dr. Ellis of C.M.I., Kew, for help in identification of the fungus.

Pathology Section,   H. N. SATYA.
Department of Botany,
Motilal Vigyan Mahavidyalaya,
Bhopal, *June* 27, 1964.

1. Pirozynski, K. A. "*Circinotrichum* and *Gyrothryx*," *Commonwealth Mycol. Inst. Mycol. Paper*, 1962, No. 84 12.

FIGS. 1–3. *Gyrothrix circinata*. Fig. 1. Setæ. Fig. 2. Conidiophores and conidia. Fig. 3. Hyphæ and conidiophores in top view. (Fig. 1 to scale B; Figs. 2–3 to scale A).
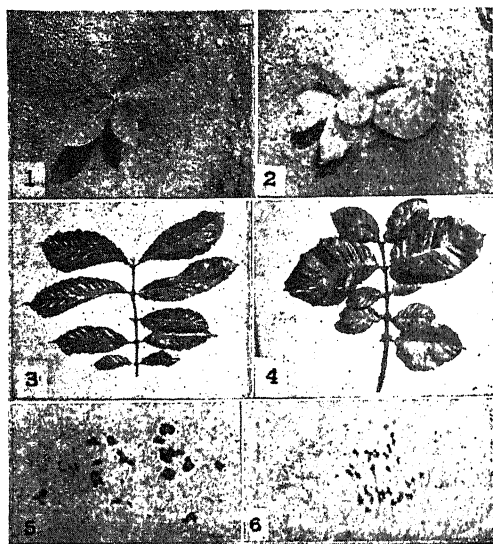
INDUCED AUTO-TETRAPLOID IN *COFFEA CANEPHORA* PIERRE EX FROEHNER

THE importance of obtaining mutations in *Coffea* by artificial means for genetical studies and breeding purposes has been stressed by Sybenga (1961). The methods so far applied are irradiation of seeds and plants to obtain point mutations (Carvalho *et al.*, 1954; Moh and Orbegaso, 1959) and colchicine treatment of seeds and sucker cuttings to induce chromosome doubling (Mendes 1939, 1947). Of the seven species in *Coffea* and a triploid hybrid of *C. arabica* × *C. canephora* where chromosome doubling has been reported, *C. arabica* ($2n = 44$), *C. canephora* ($2n = 22$), *C. Deweverei* ($2n = 22$) and the triploid hybrid of *C. arabica* × *C. canephora* have been subjected to clochicine treatment (Darlington, 1955; Krug, 1937; Mendes; 1939, 1947; Narasimhaswamy, 1946; Sybenga. 1961). Seeds wetted in sterilised soil for 30 days and treated with 0·3% colchicine have given good results in the case of the species, whereas, in the triploid hybrid and a di-haploid in *C. arabica*

ucker cuttings have been used for treatment with colchicine and grafts established from these. Chromosome doubling in the latter has resulted in restoration of fertility.

From literature available cytological details have so far been published in polyploids in *Coffea arabica* (Krug, 1937). The present note is a preliminary report on the morphology and cytology in a seedling of *C. canepora* in which tetraploidy was induced by colchicine treatment at Central Coffee Research Institute in 1955.

Growing shoot-tips of 4-month old seedlings from S. 274, a selection of *C. canephora* was subjected to colchicine treatment of varying concentrations and duration. Of these 0·3% concentration for 12 hours at room temperature gave successful results. The effect of colchicine was evident from the 'gigas' characters noticed after about a month from the time of treatment (Figs. 1 and 2) and 44 somatic chromosome number noticed in shoot-tip squashes.

FIGS. 1-6. Fig. 1. Normal diploid *C. amphora*, 5 months old. Fig. 2. Tetraploid induced by colchicine. Fig. 3. A twig from normal diploid, 2 years old. Fig. 4. twig from tetraploid, 2 years old. Fig. 5. Metaphase showing 7 iv, 2 iii; 4 ii, 2 i. Fig. 6. Anaphase I showing delayed disjunction.

Morphology.—A comparative account of vegetative and floral characteristics is given in Table I.

The tetraploid shows profuse flowering every season but the set is very low. Seeds are not uniform in size and shape as in the diploid. Selfing by bagging during 1964 flowering season is a complete failure, 100 bulk seeds were collected for raising progeny; of this, 78 germinated and 76 seedlings are existing.

TABLE I

	Tetraploid	Diploid
1. Primaries	Acute angle with the main stem, 30-35 degrees; thicker and brittle with shorter internodes	40-45 degrees
2. Leaf ..	Thick, coarse, dark green with comparatively more wavy margin	
	Length/breadth: 20·3/15·3 cm.	17·7/10·2 cm.
	Thickness 0·37 mm. (Fig. 3)	0·27 mm. (Fig. 4)
3. Stomata ..	Length/width: 27·3/19·5 in microns	17·5-19·5 13·6-15·6
	No. per sq. mm. 184·8	267·8
4. Flowers :		
Petals and	7 merous 5·7%	Nil
stamen	6 merous 71·4%	31·8%
	5 merous 22·9%	68·2%
Petals: Length/ width	1·55/0·65 cm.	1·60/0·45 cm.
Anthers: Length/ width	1·15/0·25 cm.	1·25/0·15 cm.

Cytology.—Chromosome associations were studied at Diakinesis and Metaphase (Fig. 5). These show the following features :

	(iv)	(iii)	(ii)	(i)
Range	4-7	0-3	4-14	0-5
Mean per cell	5·75	1·5	7·42	1·18

Delayed disjunction at A.I., laggards and irregular distribution of chromosomes were occasionally observed (Fig. 6). In most cases the laggards showed equational division and moved to opposite poles in time to get included in the telophasic nuclei. Equal distribution of 22-22 chromosomes to the two poles were seen in a majority of pmcs. Occasionally monads, dyads and pentads were also found. Size of pollen grains ranged from 28-44 microns in the tetraploid as against 20-36 microns in diploids. Good pollen as determined by iodine tests was found to be 96% and 79·7% in the treated and the normal plants respectively.

In the bulk seedlings from the tetraploid, indications of diploid, tetraploid and aneuploid plants are so far noticed.

Conclusions.—The technique employed to induce tetraploidy in the shoot portion of seedlings and the subsequent growth of these with gigas characters and flowering show the success of the technique.

behaviour of catalase in monocotyledon and dicotyledon leaf tissues.

Agronomy Department,   N. G. PERUR.
Utah State University,   R. L. SMITH.
Logan, Utah, U.S.A.,   HERMAN H. WIEBE.
August 20, 1964.

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TEAK OIL FROM *TECTONA GRANDIS* LINN.

TEAK (*Tectona grandis* Linn.; Family, *Verbinaceæ*) is one of the important commercial timbers of India and other tropical countries. It is valued for its durability as it is immune to insect and fungus attacks and resists wood rot. This inherent quality of teak wood is largely attributed to the presence of oil. The exact nature of the oil is not known so far and the literature on this aspect is very scanty and confusing. A reference to the works on Indian Forestry reveals that teak wood contains an oil which is easily perceptible to the touch and is preservative in character.[1] This oil is used medicinally, as a substitute for linseed oil and as a varnish,[2] apparently indicating the nature of the oil to be as that of fixed oil. Although the woods yield essential oil on distillation, no trace of essential oil was detected on distillation of teak wood.[3] Studies on the chemistry of teak heartwood by Romanis[4] and Kafuku and Sebe have revealed the presence of tectoquinone (2-methyl anthraquinone) in the steam distillate of resinous material obtained by extracting the saw dust with organic solvents. No work has, however, been reported so far on the oil. An investigation has been undertaken to study the chemistry of teak wood and also to ascertain the exact physico-chemical nature of the oil. The interim results are presented in this paper.

Teak wood on steam distillation yields 0.15% of an oil along with a solid compound (m.p. 178–79°), identical with tectoquinone of Kafuku and Sebe.[5]

Fresh shavings (10 kg., moisture, 10.15%) from a log of a brightly coloured teak wood were distilled with steam at a pressure of 2.81 kg./cm.^{2} (40 lb./in.^{2}) for 4 hours. The distillate was collected in a florentine flask and employing the 'F.R.I. Oil Trap' for the recovery of last traces of the oil in the overflowing water. On working up with ether, a thick yellowish-brown oil was obtained which on keeping deposited an orange coloured solid. By repeated congealing and filtration under suction, solid was separated from the oil. The oil obtained in 0.15% yield (zero moisture basis) and had the following physico-chemical characteristics :

Colour : Yellowish-brown ; Sp. gr. at 0.9405 ; Ref. index at 28° : 1.5023 ; Opt. rot 28° : –2.20° ; Acid value : 3.45 ; Sap. val 17.89 ; Sap. value after acetylation : 96 Sol. in 95% alcohol : 1 : 20.

The solid was purified by chromatogr over Brockmann's alumina and on crystalltion from alcohol separated as light yel fibrous needles melting at 178–79°. It agree all tests with 2-methyl anthraquinone (tquinone) of Kafuku and Sebe.[5] With dinitrophenylhydrazine, it formed a 2 : 4 dinipenylhydrazone, crystallized from alcohol ethyl acetate, melting at 254–55°. On boi with acetic anhydride, pyridine and zinc, it the diacetate of β-methyl anthrahydroqui melting at 221–22° (m.p. reported in literatu 216–17°).

Grateful thanks are due to Shri O. P. Sha for his technical assistance.

Forest Research Institute,   R. M. BERI.
P.O. New Forest, Dehra Dun,   M. G. KARNI.
September 10, 1964.

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A PROBABLE PLANT INDICATOR FO ZINC MINERALISATION IN THE ZAWAR Pb-Zn BELT, UDAIPUR DISTRICT, RAJASTHAN

IN the Zawar Pb-Zn belt the ore, consist mainly of an assemblage of sphalerite, gal and pyrite, occurs as replacement along sh zones, fractures, lithological contacts and f hinges exclusively in dolomite. The dolomit are intercalated with orthoquartzite, feldspath quartzite, phyllite, slate, graywacke a epiclastic conglomerate. These Aravalli se ments have undergone regional metamorphi in green schist facies conditions.

Surface expressions of mineralisation lik diagnostic gossan zones are absent or very po

The nature of the host rock, absence of open fractures and consequent lack of porosity and permeability, and the rugged terrain conditions are responsible for this phenomenon. The dolomite bands, in which Pb-Zn sulphides are emplaced, form strike ridges of moderate to steep slope. Residual soil cover is very thin and impersistent on the ridge tops. Limonite and siderite veins are seen on the outcrops of dolomite. Limonite is compact, devoid of box-work, and varies in colour from dark tan to ocherous yellow. Siderite is coarse crystalline, with shades ranging from tan brown to reddish brown. The physical characters do not give any clue as to whether these are derivatives of pyrite or Pb-Zn sulphide. Systematic geochemical sampling has, however, been reported to yield data as to the parentage by anomalous content of Pb and/or Zn (Straczek and Ganeshan, 1960).

The entire zone has been prospected and mined by ancient workers. The chains of these workings serve as guides to mineralisation, and at the same time introduce limitations in geochemical survey by enhancing the chances of contamination.

It is possible to isolate the probable mineralised stratigraphic horizons of dolomite on the basis of air photo mapping but the necessity of a ready reckoner is very much felt to eliminate barren zones in the dolomite horizons and demarcate blocks for detailed exploration.

Normally geological work in these areas is conducted during the winter and summer months when vegetation is sparse. During the period August 27 to August 31, 1964, the author revisited some parts of the Zawar belt, *e.g.*, Hameta mogra near Goira village (24° 23′ : 73° 39′) and the Mochia and Balria mogras, 4·5 km. S.E. of Hameta mogra and where the producing zinc-lead mines are located. During the monsoon, the valleys and hills are covered by lush green vegetation. In the Hameta mogra, various types of flowering plants and shrubs grow in abundance of which a species of balsam with single-whorled purple flowers shows a striking selectivity for dumps and outcrops of sphalerite. A reconnoitry tour in the Mochia-Balria (*i.e.*, in the producing mine area) revealed the same distribution pattern. Enormous population of the species was found along the southern flank of the Mochia and Balria.

It is unlikely that the plant favours the soil derived from dolomite because in areas where dolomite is barren of zinc sulphides, the species does not grow. The presence of Pb is perhaps

also not necessary as in the Hameta area sphalerite is the dominant sulphide, and galena is present only in minor proportion.

Table I gives the details of this plant species,

TABLE I

Element	Local/ Universal	Family	Genus and species	Common name	Locality
Zn	U	Violet	*Viola cala- minera* (*Lutea*)	Zinc violet	Belgium Germany
	L	Saxifrage	*Philadel- phus* sp.	Mock orange	Washington
	L	Gerania- ceae	*Impatiens balsamia*	Balsam	Zawar belt

and of others reported from Europe and America (Hawkes and Webb, 1962, p. 312) as zinc-indicator plants.

The preliminary empirical data indicate that the coincidence between the distribution of *Impatiens balsamia* and Zn mineralisation in the Zawar belt is unlikely to be accidental. Systematic search will be conducted during the next monsoon to establish the relationship.

Not much data are available on geobotanical prospecting for metals in India. Indicator plants, once recognised, give a direct clue to the areas of possible mineralisation.

Bairathi Bhawan,   B. C. PODDAR.
Prithviraj Marg,
Jaipur, *September* 28, 1964.

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ON THE SUSCEPTIBILITY OF *MACACA MULATTA* TO INFECTION WITH *SCHISTOSOMA INCOGNITUM*

WHILE human schistosomiasis, believed to be schistosomiasis hæmatobia, is endemic only in a small village in Ratnagiri District of Maharashtra (Gadgil and Shah, 1952), animal schistosomiasis is prevalent throughout this country. At least eight species of schistosomes of domesticated mammals occur in India (Srivastava and Dutt, 1962). Both from the public health and veterinary standpoints, it is necessary to know

ONION ROOT GIBBERELLINS

THE naturally-occurring gibberellins of seeds and leaves of higher plants have been well investigated while those of roots have relatively been little studied.[1-3] Therefore it is of interest to examine the native gibberellins of actively growing roots. The roots of onion plant, *Allium cepa* were selected for this investigation.

Onion plants were grown from bulbs in pans of sand under natural conditions in the garden. Twenty days after planting the roots were separated from the plants, washed, and were subjected to the extraction of gibberellins according to the method of Corcoran and Phinney.[4] The roots (about 20 g.) were ground in acetone : water (1 : 1), the macerate was left for 24 hours at 15° C. and was filtered. The filtrate was concentrated on a boiling water bath and was used for paper chromatographic analysis of gibberellins.

The sheets (Whatman No. 1) were run unidirectionally in an ascending technique in three different solvent systems (Table I). Dried papers were sprayed with the chromogenic reagent,[5] 0·5% aqueous potassium permanganate to detect gibberellin-like substances which appear as yellow spots on purple background.

The analysis showed that two compounds positive to permanganate reagent were present in the extract. The chromatographic behaviour of these substances is summarized in Table I.

TABLE I

Chromatographic characteristics of gibberellin-like substances in onion roots

	n-Butanol/ Acetic acid/ water 19 : 1 : 6	n-Butanol/ 1·5 N Ammonium hydroxide 3 : 1	Isopropanol/ 7 N Ammonium hydroxide 5 : 1
Substance 1 ..	0·86	0·22	0·58
Substance 2 ..	0·46	0·08	0·44

Substance 1 had identical behaviour in all the solvents tried in respect of Rf with the authentic sample of Gibberellic acid (gibberellin A₃). Additional confirmation was also obtained by spraying the sheet with 0·05% ferric chloride in 3·0% methanolic sulphuric acid.[6] Both the unknown and the authentic samples had no colour in visible light, but fluoresced blue green under U.V. light.

Bioassay of the above native gibberellic acid was done using rice seedling test.[7] The spot corresponding to A₃ was eluted with acetone : water (1 : 1) from the unsprayed sheet and eluate was evaporated to a small known volume and was tested for biological activity. The

elongation of second leaf-sheath in rice seedlings of variety BCP I was measured and it was found that 6 g. of root material was equivalent to 1·0 μg. of authentic gibberellic acid in biological activity. Substance 2 is at the moment unidentified.

Thus the present investigation has revealed occurrence of gibberellin A₃ and an unidentified gibberellin in onion roots and it is highly probable that roots of other plants also contain similar native gibberellins. It is pointed out that gibberellic acid promotes synthesis of phenolic compounds which in turn control growth by way of increased auxin content.[8] Phenolic acids of onion roots have recently been studied by the present authors[9] and further work on the levels of native gibberellins and phenolic substances during different developmental stages will be most helpful in understanding the growth of roots.

The authors thank Prof. I. M. Rao for encouragement.

Department of Botany,   V. S. R. DAS.
S.V. University,   J. V. S. RAO.
Tirupati (A.P.), *September 28, 1964.*

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SOME OBSERVATIONS ON THE EMBRYOLOGY OF *HOLBOELLIA LATIFOLIA* WALL.

THE family Lardizabalaceæ is given an independent status by Engler and Prantl,[2] Hutchinson[3] and Rendle,[5] while Bentham and Hooker[1] treat it as a tribe of the Berberidaceæ. The earlier embryological findings on this family include those of Vesque[8] on *Holboellia latifolia,* Vesler[7] on *Akebia quinata,* and Swamy[6] on *Decaisnea insignis.* The first two authors reported formation of parietal cells in the ovules. In addition, Vesler[7] made some observations on the pollen grains and embryo-sac. Swamy,[6] besides investigating pollen and embryo-sac, also traced the development of endosperm.

The material of *Holboellia latifolia* was collected from the Lloyd Botanic Gardens,

id Tonglu in the same district,
ine 1962. The plant is a monœ-
; shrub. The unisexual flowers
purplish-green and sweet-scented.
sepals arranged in two whorls,
cular petals, 6 free stamens, and
els with oblong stigmas.

wall consists of an epidermis,
ecium, two or three middle layers
ory tapetum. The tapetal cells
: nuclei each which later fuse to
l masses.

.on divisions in the microspore
re simultaneous resulting in tetra-
ussate tetrads. The mature pollen
colpate and 2-celled at the time
ïg. 1).

le flowers the anthers degenerate.
may, however, develop up to the
ollen grain stage.

shows parietal placentation bear-
sub-sessile ovules, separated from
y multicellular, uniseriate hairs
n the inner epidermal cells of the
These ovules are orthotropous,
rassinucellate with well-developed
formed also by periclinal divisions
ar epidermis (Figs. 2, 3). The
rganized by the inner integument

here is single (sometimes two)
ther cell. It divides to form a
, of which the upper dyad cell
s remain undivided (Figs. 5, 6).
dyad cells divide (Fig. 7) mostly
ads of megaspores (Fig. 8), and
near ones, are produced. The
spore functions and the develop-
embryo-sac thus conforms to the
pe (Maheshwari[4]).

al megaspore divides to form 2,
ate gametophytes (Figs. 9, 10).
r quartet organizes earlier than
uartet. The mature embryo-sac
egg apparatus, two polar nuclei
podal cells (Fig. 10). The latter
l and degenerate even before

rm is cellular. The first division
endosperm nucleus is transverse
ge micropylar and a small chalazal
11). Both the chambers contri-
the endosperm formation, but
ore rapid in the chalazal region.
ie of *Decaisnea*.[6]

A comparative study indicates that Lardi-
zabalaceæ deserve the status of an indepednent
family and need not be merged with the Berbe-
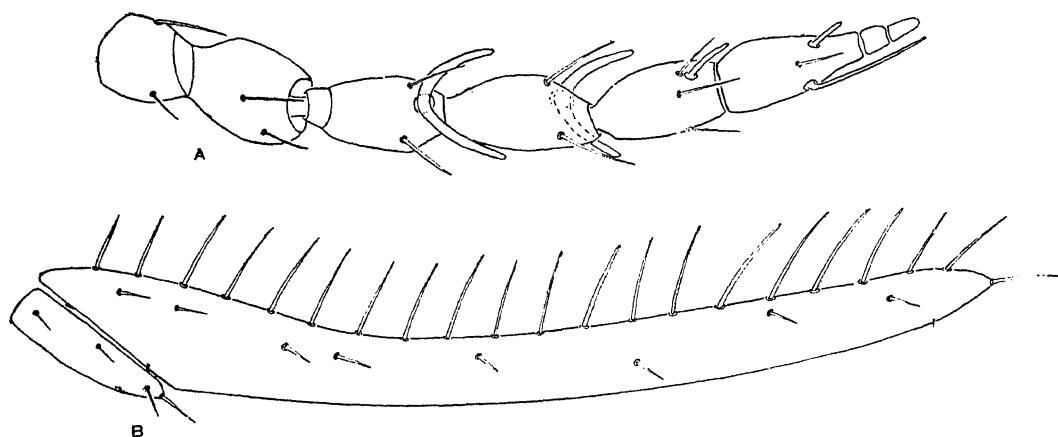ridaceæ.

FIGS. 1-11. Fig. 1 Mature pollen grain. Fig. 2.
Ovule. Fig. 3. Portion of ovule enlarged to show mega-
spore mother cell. Fig. 4. Dyad. Figs. 5-6. Lower
dyad is dividing while the upper one is degenerating.
Figs. 7-8. T-shaped tetrads of megaspores. Figs. 9-10.
Two-nucleate and mature embryo embryo-sacs respectively,
In Fig. 10. the polars have fused. Fig. 11. Fertilized
embryo-sac showing two-celled endosperm and persistent
synergid. (Fig. 2, × 100; Others, × 450).

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FIGS. A–B. Fig. A. Dorsal view of left antenna of female. Fig. B. Right forewing and scale of female.

head. Mouth cone broad, in normal expansion just reaching hind-margin of prosternum.

Pronotum ·065 mm. long, as wide as head in front and ·150 mm. wide on posterior margin ; with sides diverging in anterion half and parallel in posterior half ; bearing ten or twelve micro-setæ on the disk and a stout, pointed seta on the hind margin, half-way between the meson and the posterior angle. Pronotum and mesonotum densely striated with delicate, transverse, sub-parallel lines. In a lateral view of the prono-tum these striæ converge upon a slight inden-tation which marks the lateral apodeme. Metanotum with a pair of microsetæ far apart on the anterior margin and a similar pair closer together on the disk and removed by their own length from the margin ; with reticular striation which is clear on the disk but faint on the sides.

Wings with dense rows of microtrichia, with long, straight fringe hairs on both margins. Fore-wing with 18-20 weakly curved, stout spines on the fore-margin. The fore-vein marked by short, stout, dark spines arranged in 2-2-1-2 series. The hind-vein always with only one spine, just basad of the penultimate spine on the fore-vein. Hind-wing much lighter than fore-wing, with a conspicuously dark central band along its entire length. Scale long and narrow, with one dark spine on the disk near the base, two near the distal half of the anterior margin, and one at the end. Wing retaining setæ closely paired, long, thin, pale colored.

Legs hairy. Posterior tibiæ with a strong straight spine above the inner hind angle, and a much smaller spine at the angle itself.

Abdominal tergites 2-8 with a narrow dark band across the entire front margin. Tergites

1-7 smooth in the mesal third but with dense rows of microtrichia on the lateral thirds, the microtrichia extending into setiform combs dis-tad of the hind-margin. Tergite 8 with a regular comb along the entire margin ; with the lateral microtrichial areas joining in the front half of the tergite to leave only the mesal third of the distal half smooth. Tergites 2-8 with three microsetæ on the transverse midline of each microtrichial area, a smaller microseta on each side of the meson, and a relatively long, stout seta at each posterior angle. Tergite 9 with a pair of stout spines far apart on the transeverse midline and three on each side of the posterior margin ; the middle one of the latter colorless and much weaker than the other two. Tergite 10 with four terminal setæ, all stout but the inner pair darker than the outer pair. The ster-nites are pubescent on the lateral thirds, but the microtrichia are shorter than on the tergites and appear like stippling. Sternites 2-7 bear six relatively strong setæ on the posterior margin, none on the disk. Sternites 5-7 bear a dark arcuate band along the anterior margin.

Measurements of female holotype in microns.— Body length 624 ; length of head to tip of labrum 160 ; length of eye 50 ; width of head across eyes 135 ; length of pronotum 65 ; width of pronotum at posterior margin 150 ; width of metathorax in front 200 ; spine on posterior margin of prono-tum 45 ; posteroangular spines on 9th abdominal tergite 50 ; length of comb on 8th abdominal tergite 10 ; microsetæ on disk of metanotum 15.

Antennal segments :	1	2	3	4	5	6	7	8	Total
Length	20	25	35	32	36	35	5	10	198
Width	20	25	15	15	15	12	5	2	

Macropterous male.—592 microns when fully expanded; like the female in color, shape and pubescent areas; with abdominal segment 9 bearing six stout spines with prominent bases arranged in a semicircular line on the disk of the tergite, and a strong, dark inwardly curved drepanum on each side.

Described from the female holotype, the male allotype, one male and eighteen female paratypes collected during March and April 1964, and three female paratypes collected January to March 1963. This material is now in the author's collection and will eventually be deposited with the Bernice P. Bishop Museum, Honolulu, Hawaii.

Experiment Station,   F. A. BIANCHI.
Hawaiian Sugar Planters' Assn.,
Honolulu, Hawaii, U.S.A.,
November 12, 1964.

EPICOCCUM NIGRUM LINK ON STORED FRUITS OF ZIZYPHUS JUJUBA LAMK

DURING December 1962, a storage rot disease of *Zizyphus jujuba* (Vern. *Ber*) was observed in the local markets. The infected fruits had chocolate-grey to dull-black spots. Isolations from diseased areas gave a species of *Epicoccum*. Pathogenicity was tested both by injury and contact methods. Since the fungus has not been recorded on this host earlier a brief account of symptoms and morphology of the organism has been recorded here.

The disease starts as small light-brown spots with a water-soaked appearance. These spots gradually enlarge in size and their colour changes to dark brown. Some times spots coalesce to form bigger spots and they become chocolate-grey to dull black with black margin. These spots remain quite distinct from the healthy portion of the fruits. A section of the diseased fruit shows that the fungus causes a soft rot of the fleshy tissue.

The fungus grows well on Asthana and Hawker's Medium 'A' at 25° C. (± 2° C.). In culture the mycelial colony is brownish-yellow in colour. Sporodochia are scattered and hemispherical in shape. Conidiophores are club-shaped, brown in colour, $4 \cdot 5$–$7 \cdot 0 \times 12 \cdot 0$–$14 \cdot 3\,\mu$ in size. Conidia are spherical, $20 \cdot 4$ to $25 \cdot 0\,\mu$ diameter, brown in colour, borne singly at the tip of conidiophores. Conidial surface is verruculose. On the basis of the above morphological characters the organism is specified as *Epicoccum nigrum* Link and it has been confirmed by Com-monwealth Mycological Institute, Kew, Surrey, England. This species of *Epicoccum* has earlier been recorded on maize (Ellis, 1956)[1] and *Ginkgo biloba* (Neely, 1959)[2] in U.S.A. Cross-inoculations were successful only on the fruits of *Prunus persica* Stokes and *Cucumis melo* L. while it failed to infect *Pyrus malus*, *Pyrus communis* L., *Trichosanthes dioica* Roxb. and *Cucumis sativus* L.

A culture has been deposited at the Commonwealth Mycological Institute, Kew, Surrey, England (C.M.I. No. 95017), and also at the Plant Pathological Laboratory of the Botany Department, Allahabad University.

Our grateful thanks are due to Dr. J. C. F. Hopkins of C.M.I., Kew, Surrey, England, for confirming the identity of the fungus.
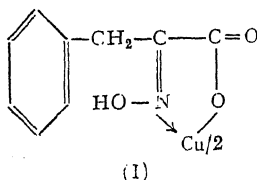
Plant Pathological Laboratory, SUDHIR CHANDRA.
Botany Department,   R. N. TANDON.
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CHROMOSOME DIMINUTION IN THE ROOTS OF ALOE VERA L.

SOMATIC reduction has been recorded as an unusual feature in certain plant species. Ross and his school have reported on the colchicine-induced somatic reduction where a full genome gets eliminated in the somatic tissues of *Sorghum vulgare*.[1] Comparable phenomena have been recorded recently in the normal roots of *Allium*.[2] Instead of the full genome one or a few chromosomes may get eliminated from one or more tissues of the plant. Thus in *Xanthisma taxanum*,[3] *Sorghum purpureo-sericeum*,[4] *Haplopappus gracilis*,[5] *H. spinulosa*[6] and *Crepis pannonica*[7] the accessory chromosomes are found in the germ line but not in the roots. Sampath[8] recorded chromosome diminution in the roots of *Oryza sativa* × *eichingeri*. A situation where some chromosomes of the regular complement get eliminated only in a part of the root system while other roots and the germ line possess the normal chromosome number has been observed in *Aloe vera* and is reported here.

While studying the chromosome complement of *Aloe* a few roots were observed to have $2n = 10$ instead of $2n = 14$, the normal diploid number. However, on further investigation a part of the same root system showed $2n = 14$ also. The entire root system was therefore divided into 8 sectors and 5 randomly selected root-tips were studied from each. It showed

(I)

was filtered through a sintered glass crucible No. 4 There was no need of digesting the precipitates on water-bath. The precipitates on the crucible were washed twice with 20% ethanol and dried at 110-15° C. in an oven. The results obtained are in conformity with those obtained by precipitation of the complex with PPAO.

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Department of Chemistry,   MOHAN KATYAL.
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ON THE USE OF ACYL SEMICARBAZIDE FOR THE SYNTHESIS OF ALDEHYDE

IN connection with a need for an aldehyde in the syntheses of *iso*-quinoline derivative that are being followed in this Institute, an attempt was made to utilise the reaction as developed by McFadyen and Stevens,[1] but by using N_1-acyl semicarbazide in place of benzene sulphonyl acly-hydrazine. A mixture of benzoyl hydrazine and urea in molecular proportions was heated under reflux for 10 hours in aqueous solution to give N_1-benzoyl semicarbazide, m.p. 226° (decomp.) on crystallisation from water (Found : N, 23·1% ; $C_8H_9O_2N_3$ requires, N, 23·4%). In a similar way several other acyl semicarbazides have been prepared (*cf.* Guha[2]) from p-chlorobenzoyl, anisoyl-, *iso*-nicotinoyl- and 1 : 3-dimethyl 3 : 4-dihydro-*iso*-quinoline-3-carboxy hydrazines and the respective melting points of the corresponding semicarbazides are 225–26°, 226–27°, 244–45° (decomp.) and 193–94°,

The benzoyl-semicarbazide (9 gm.) when heated with sodium carbonate (11 gm.) gave an oil, b.p. 178-79°, whose 2 : 4-dinitrophenyl hydrazone crystallises from ethyl acetate in orange yellow needles, m.p. 235-36°, not depressed when admixed with an authentic sample of 2:4-dinitrophenyl hydrazone of benzaldehyde. (Found : N, 19·05% ; $C_{13}H_{11}O_4N_4$ requires N, 19·5%).

In using urethane in place of urea a different type of reaction was noticed. Thus, for example, when *iso*-nicotinoyl hydrazine was heated with urethane on a wiregauze furnished 2-(4′-pyridyl)-1, 3 4-oxadiazole-5-one, m.p. 266-68° (decomp.) (Found : N, 25·51 ; $C_7H_5N_3O_2$ requires N, 25·77%). The properties of the compound agree in all respects with those of the similar product from *iso*-nicotinoyl hydrazine and carbonyl chloride (*cf.* Smith[3]). The work is in progress.

Bengal Immunity   SAKTI PADA DUTTA.
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Calcutta-16,   U. P. BASU.
November 23, 1964.

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2′, 3′, 4′-TRIHYDROXYCHALCONE AS AN ANALYTICAL REAGENT

LENSE *et al.*[1] examined the reactions of metallic ions with chalcones and reported that they are more sensitive than the aldehydes and ketones from which they are prepared. Tokuichi Tsumaki *et al.*[2] investigated the reactions of 4-chloro-2′-hydroxychalcone and 2, 2′-dihydroxychalcone with copper acetate in alcohol medium and obtained dark yellowish orange needles and dark yellow needles respectively. These complexes are shown to be of definite chemical composition. Gy Almassy *et al.*[3] reported on the use of 2′-hydroxy-4-nitrochalcone in microanalysis for the direct determination of alkaline earth metals. These authors reported that this reagent yielded precipitates exclusively with divalent metals and that the three functional groups present in it were involved in complex formation. Saiyad *et al.*[4] reported that 2′, 4′-dihydroxychalcone yielded an intense reddish brown color with ferric iron. The present author[5] carried out spectrophotometric investigation on the color reaction and estab-

d that the composition of the complex
ied with Fe(III) was 1 : 3.

mong the chalcones under investigation by
present author it was found that 2′, 3′, 4′-tri-
oxychalcone gave a brown precipitate with
5γ of Cu(II) at a dilution of 1 in 4×10^5.
amperometric method of estimation carried
by the author[6] with this reagent yielded
l results for 1·0–6·0 mg. of copper. Further
stigations showed that this reagent was
ly sensitive, though not equally specific,
veral other di-, tri- and tetravalent metallic
. Among the ions examined only uranyl
08γ) gave an orange color at pH 3·9–5·5 and
dilution of 1 in $1·6 \times 10^5$. At a higher
(5·7–8·4), however, an orange precipitate
obtained. In all other cases precipitates
obtained within the pH range given in
e I.

TABLE I

al 1	Colour	pH	Limit of Indentification γ	Limit of dilution
	Brown	3.8–4.5	0·125	4,00,000
	Dark brown	6·8–8·2	0·320	1,56,000
	Orange brown	3·9–5·9	1·250	40,000
	Orange	6·1–8·2	2·500	40,000
	Orange brown	5·S–6·4	0·154	1,62,000
	Dark brown	6·3–8·0	2·500	20,000
	Orange brown	5·0–6·7	0·256	3,89,700
	′′	4·7–5·0	0·320	1,56,000
+	Grey	2·6–5·3	0·200	2,50,000
+	Dark brown	5·4–7·5	1·000	50,000
	Orange red	4·7–6·6	0·800	62,400
	Orange brown	3·1–4·0	0·312	1,60,300
+	Chacolate brown	1·5–2·5	0·0625	8,00,000
++	Orange	3·7–4·4	3·000	16,600
++	Yellow	4·1–6·4	0·625	80,000

is obvious that by controlling the pH range
selectivity of the reagent could be enhanced.
analytical applications of this reagent with
metallic ions are under investigation.

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irtment of Chemistry,   K. SYAMASUNDER.
University, Tirupati,
i, *October* 27, 1964.

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OCCURRENCE OF RAPAKIVI GRANITE IN SOUTH INDIA

FOR the first time, in South India is recorded
an occurrence of rapakivi granite and grano-
diorite at Manapparai (10° 36′ : 78° 26′), Tiru-
chirapalli, Madras State. The outcrop covers an
area of about five square miles. The rocks
could be traced up to the village of Kudirai-
kuttippatti, two and a half miles N. 30 W. of
Manapparai and in the hill 950 west of the
village. Outcrops are also noted round about
Andavarkovil, a mile and a half north-east of
Manapparai.

The rock mass is traversed by horizontal and
vertical joints. The quarries that were opened
in 950 hill have been abandoned, as the rocks
easily crumble—a characteristic of the rapakivi
granite which has earned for it the name rotten
stone.

The rapakivi structures are conspicuously
absent in the geologically associated rocks,
outside the area referred to. The rapakivi
granites are traversed by pegmatites and aplites
parallel to and across the foliation.

Within the area the ovoids make their
appearance at the contact with the granodiorites,
which have developed a foliation. The rapakivi
structure is typical. The ovoids of orthoclase
microcline and perthite—varying in size from
about one-fourth to a maximum of two inches—
are surrounded by mantles of plagioclase
(Ab_{70} An_{30}), wart-like intergrowths of vermi-
cular quartz and plagioclase and hornblende.
This ferromagnesian is observed in the micro-
sections in parallel, subparallel and tangential
positions to the potash felspar. The matrix also
shows potash felspars and plagioclase besides
hornblende and biotite. The felspars therefore
occur in two generations.

Various views have been given for the
genesis of the ovoids, which have been sum-
marised by Read.

The magmatists hold that they are due to
(*i*) crystallisation of drops of magma shed from
the felspars (Holmquist); (*ii*) eutectic crystal-
lisation of orthoclase and oligoclase (Vogt);
(*iii*) refusion of the early formed orthoclase
under conditions of reduction of gas pressure
(Wahl.); (*iv*) a disturbed phase equilibrium in
the crystallisation of the magma (Eckermann);
(*v*) supersaturation of orthoclase and oligoclase
alternatively (Harker); (*vi*) depletion of potash
of the orthoclase—giving rise to oligoclase due
to the potash being fixed up in biotite (Thomas
and Cambell Smith); (*vii*) **progressive con-**

THE NEW PHYSIOLOGY OF VISION

Chapter VIII. The Perception of Polarised Light

SIR C. V. RAMAN

ONE of the most remarkable of our visual faculties is the ability to recognise polarised light and to locate its plane of polarisation. It is the foveal region of the retina that exhibits this power which, it may be remarked, is limited to light appearing in the wavelength range between 400 mμ and 500 mμ. The fovea is the most useful part of the retina and the blue-violet sector in the spectrum covering this range of wavelengths stands in a category by itself as the most colourful and yet the least luminous part of it. Clearly, therefore, the process by which the fovea is enabled to recognise the presence of polarisation in light appearing in this restricted range within the spectrum and is unable to achieve the same result in other parts of it, merits scientific investigation. Indeed, one may well expect that such an investigation would throw much-needed light on the fundamental aspects of the physiology of vision. The studies of which the results are described in this chapter were undertaken with that object.

Haidinger's Brushes.—The blue colour of the sunlit sky has its origin in the scattering of sunlight by the molecules of the earth's atmosphere. Skylight accordingly exhibits a high degree of polarisation when observed in a direction transverse to the rays of the sun. As a consequence, observation of the parts of the sky which exhibit the maximum degree of polarisation should enable us to demonstrate the ability of our eyes to perceive and determine the state of such polarisation. The effects thus arising are best looked for in the forenoon of any bright clear morning when the sun is well up above the horizon. The observer should stand with his back to the sun and view the regions of the sky where the maximum of polarisation is to be expected. These regions would evidently lie along the arc of a great circle which runs at a slant across the sky. Scanning this circle rapidly with his eyes, the observer will notice a band along the circle which appears bluer than the rest of the sky and which is bordered on both sides by bands of the same width exhibiting a distinctly yellowish hue. On fixing his attention at a particular part of the circle to his left, it will be found that the colours seen in that region soon fade away from sight. The observer should

then turn quickly and fix his attention on the part of the great circle to his right which is ninety degrees away from the original point of fixation on the left. He will then notice in this region a very striking phenomenon, *viz.*, a dumbell-shaped blue brush of light having its axis on the great circle of maximum polarisation of skylight and crossing this brush a yellow brush of light of similar shape with its axis transverse to that circle. These brushes are conspicuous when first seen, but when the observer continues to gaze at them, they fade away from sight. He should then again turn quickly to the region on the circle previously viewed. He will then notice in that region a similar conspicuous manifestation of the blue and yellow brushes crossing each other. This alternation between the left and the right can be repeated as often as desired.

Studied in the manner described, the nature and origin of the phenomena become clear. What the observer perceives is an enormously enlarged picture of the foveal region in the retinæ of his own eyes projected on the sky and manifesting itself by reason of the visual response of the fovea to the light incident on it. The spectral character of that light, its state of polarisation and the orientation of the plane of polarisation in relation to the fovea are the factors which determine the nature of the picture perceived. The circumstances in which it is observed indicate that the conditioning of the eye by an earlier exposure to polarised light also plays a highly important role. The entire light of the spectrum is polarised, but the part of the spectrum not included in the range of wavelengths between 400 mμ and 500 mμ behaves quite differently from the part which is included in that range. It is the latter part of the spectrum that evokes a powerful visual sensation in the two sectors of the fovea of which the axis is parallel to the direction of vibration in the incident light. The two other sectors of which the axis is perpendicular to that direction are not thus excited. Since these differences appear only in the blue-violet sector of the spectrum, the visual sensation in the former case manifests itself as a brush of a bright blue colour. In the latter case, the absence of any sensation in the blue region of the spectrum results in only the rest of the